United States Department of State

Bureau of Political-Military Affairs
Directorate of Defense Trade Controls

Washington, D.C. 20520-0112

JUL 14 2004

In Reply Refer to
DTC Case **TA 0966-04**

Mr. Ron Alexander
Analex Corporation
5904 Richmond Highway, Suite 300
Alexandria, VA 22303

YOUR LETTER DATED: April 12, 2004
AGREEMENT FOR: Technical Assistance
FOREIGN LICENSEE: Centre National d'Etudes Spatiale (CNES) – France
COMMODITY: Technical Data and Defense Services for Performance as NASA's Launch Support Services Contractor for the CALIPSO Satellite

Dear Applicant:

The Department of State approves the request as identified subject to the limitations, provisos or other requirements stated below. The agreement may not enter into force until these requirements have been satisfied. Any request for extension must be submitted to the Department for approval no later than 60 days prior to the authorized expiration date.

Sincerely yours,

for Peter J. Berry
Director, Office of Defense
Trade Controls Licensing

LIMITATIONS, PROVISOS AND OTHER REQUIREMENTS:

1. This authorization **expires December 31, 2008.** Prior to signature, the applicant must change Article 3.I.(3) and Additional Terms paragraph 1 to be consistent with this date.

2. Sublicensing is not authorized under this agreement. Prior to signature, the applicant must delete the current text of Additional Terms paragraph 2 and replace with wording to indicate sublicensing is not authorized.

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3. The applicant may not export hardware, software, technical data or defense services against this agreement until all parties have executed the agreement. In accordance with 22 CFR 124.4(a), submit one copy of the signed agreement, revised as may be required herein, to this office no later than 30 days after it enters into force. The applicant must inform DTC within 60 days if deciding not to execute this approved agreement.

4. If the agreement is not executed within one year of this approval, a written report as to the status of the agreement must be submitted to this office on an annual basis until the requirements of 22 CFR 124.4 or 22 CFR 124.5 have been satisfied.

5. Shipment of hardware against this agreement under the provisions of 22 CFR 123.16(b)(1) or by separate license (i.e., DSP-5, DSP-73) is not authorized. Hardware shipment may take place only after the Department of State approves an amendment to the agreement.

6. NASA indicates the launch is scheduled for April 2005. Prior to signature, applicant MUST change the second WHERAS statement in the agreement to reflect this date.

7. Prior to signature, the applicant MUST replace the first sentence of the seventh paragraph of the agreement from "CNES has contracted with Alcatel, ..." to "CNES has contracted with Alcatel, the builder of the PROTEUS spacecraft bus, for the CALIPSO spacecraft bus. CNES contracted with European Aeronautic Defense and Space (EADS) Sodern for the Imaging Infrared Radiometer (IIR)."

8. Prior to signature, the applicant MUST change the first sentence of Article 3.I.(1) to read "Analex will work with the French CALIPSO payload satellite partner CNES."

9. The applicant's independent analyses products or test data released MUST be limited to results only. Design or technical analysis tools or methods of assessment (models, algorithms, databases, or software), which are NOT in the public domain MUST NOT, be offered or released.

10. Software source code, operating algorithms, and program maintenance documentations MUST NOT be discussed, offered, or released.

11. Technical meetings and activities between the applicant and the foreign consignee may be attended and observed by the US launch service provider.

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However, the US launch service provider may NOT actively participate in those technical activities since they are NOT a signatory to the applicant's TAA. The applicant MUST inform the US launch service provider of this restriction.

12. Foreign national(s) MUST NOT be granted access to other facilities, equipment, or work being performed in support of the USG, or to information systems that provide access to additional technical data sources, files, or technical data not authorized for release under this TAA.

Technical Assistance Agreement for CALIPSO

This agreement is entered into between Analex Corporation (Analex), an entity incorporated in the state of Delaware with offices at 5904 Richmond Highway, Suite 300, Alexandria, VA 22303 and the Centre National d'Etudes Spatiale (CNES), a French agency with offices located at 2 place Maurice Quentin, 75 039 Paris Cedex 01, France, and is effective upon the date of the last party to sign the agreement.

WHEREAS Analex will provide technical assessment and mission qualification pre-launch services for the Cloud-Acrosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite to CNES under its Expendable Launch Vehicle Integrated Support (ELVIS) contract with NASA; and

WHEREAS NASA's Langley Research Center in Hampton VA leads and manages CALIPSO for the NASA Earth System Science Pathfinder (ESSP) program and collaborates with the French space agency (CNES), Ball Aerospace and Technologies Corporation (BATC), Hampton University, and the Institute Pierre Simon Laplace (IPSL) in Paris. CALIPSO, scheduled for launch in April 2004, is designed to operate for three years.

WHEREAS CNES is responsible to design, manufacture, produce, and assemble the CALIPSO spacecraft;

NOW THEREFORE, the parties desire to enter into the Technical Assistance Agreement as follows:

1. The National Aeronautics and Space Administration (NASA) has negotiated a formal Memorandum of Understanding or MOU (ANNEX A) with CNES that has the former agree to use its launch services contract to launch the French-built CALIPSO to support its operations once on orbit, checked out, and functioning; and to share the Earth science data that CALIPSO will produce. The MOU calls for the signatories' centers and contractors to produce a detailed breakout of the tasks and responsibilities of the parties called a CALIPSO Project Plan (ANNEX B) that shall be empowered by the MOU and have the force of an international cooperation agreement concluded by NASA and CNES on its behalf.

CNES has contracted with Alcatel, the builder of the PROTEUS spacecraft bus, for the CALIPSO spacecraft bus. CNES contracted with European Aeronautic Defense and Space (EADS) Sodern for the Imaging Infrared Radiometer (IIR.) CNES will integrate the payload and the spacecraft and operate the spacecraft once it is on orbit. (Note: Raytheon is assisting CNES with this task under a separate agreement, TA 2527-02.) BATC will develop the laser detection and ranging (LIDAR) and the Wide-Field Camera (WFC) for CNES to integrate. Hampton University and IPSL will provide Co-Principal Investigators (Co-PIs) to conduct experiments with CALIPSO as described in Exhibit 2.

NASA has contracted with Analex to perform a safety and mission assurance oversight role, launch site support engineering role, a launch operations management role, a mission integration coordination role, a communication and telemetry support role, to provide technical services to

the NASA/Analex Launch Engineering Team (LET), provide on-site technical, security, and administrative support and assist in the technical preparation of the spacecraft at Vandenberg AFB, California, provide mission analysis of the following analytical areas: Loads and Structural Dynamics, Dynamic Environments, Stress, Flight Design, Flight Software, Controls and Stability, Thermal/Thermodynamics, Electromagnetic Compatibility & CFD/Aerodynamics, and perform engineering and analyses for the NASA Program, which necessitates this agreement.

This Technical Assistance Agreement (TAA) is required so that Analex can carry out its responsibilities. Analex personnel will perform the work on site at Vandenberg AFB, California to get the Delta launch vehicle and CALIPSO payload integrated and ready for launch, and other tasks required of it by the CALIPSO Project Plan and the ELVIS contract Statement of Work or SOW (ANNEX C).

Analex must be able to work closely with the U.S. launch services provider, The Boeing Company (Boeing), and with the French payload contractor, CNES. Analex' work with Boeing and CNES may involve any or all of the services, tasks, and technical data described in the CALIPSO Project Plan and the ELVIS SOW. That is, Analex must be able to help integrate the spacecraft payload with the launch vehicle, assure its interfaces with ground systems are optimal, solve engineering and technical problems on the spot, and perform other, related work with CNES at Vandenberg.

This TAA does not include Boeing, BATC, or Analex Corporation's subcontractors aiSolutions Corporation and Science Applications International Corporation (SAIC). BATC and Boeing have their own TAAs with CNES, TA 0293-02, and other U.S. entities will submit their own license or TAA applications as these prove to be necessary.

2. It is understood that this Technical Assistance Agreement is entered into as required under U.S. Government Regulations and as such, it is an independent agreement between the parties, the terms of which will prevail, notwithstanding any conflict or inconsistency that may be contained in other arrangements between the parties on the subject matter.

3. The parties agree to comply with all applicable sections of the International Traffic in Arms Regulations (ITAR) of the U.S. Department of State and that more particularly in accordance with such regulations the following conditions apply to this agreement:

I. **ITAR Section 124.7**

(1) Analex will work with the French CALIPSO payload satellite partner, CNES. Analex' work with CNES may involve any or all of the services, tasks, and technical data described in the CALIPSO Project Plan and the ELVIS SOW. That is, Analex must be able to help integrate the spacecraft payload with the launch vehicle, assure its interfaces with ground systems are optimal, solve engineering and technical problems on the spot, and perform other, related work with CNES at Vandenberg. No hardware will be manufactured or exported under this agreement.

(2) NASA has procured and will provide launch services on a Boeing Delta II heavy-lift vehicle and pre-launch engineering support. This includes providing NASA engineering support

for CNES spacecraft design and development (including mission design, associated Interface Control Documents or ICDs, payload processing and integration), identifying and implementing mission unique requirements, providing early orbit engineering support, and providing NASA oversight of the CALIPSO program as needed to satisfy requirements of the ICD. NASA and its contractors will jointly develop and verify ICDs on the interface between CALIPSO and the launch vehicle. Analex will support NASA with payload integration and testing (I&T) services on the launcher.

Meetings and telephone conversations/conferences will take place as necessary to maintain control of respective areas of responsibility, on an as required basis. As a general rule, no contractors will be in attendance without prior approval, on an as needed basis.

Working Groups will be conducted in accordance with the ELVIS contract.

Reviews and Launch Site Activities will be on an as required basis, and parties will be invited to attend as appropriate.

Technical interface will include ICDs, Contamination control plans, Launch Site Test Plan, Launch Site Procedures, etc., as per the CALIPSO Project Plan and the list of documents at EXHIBIT 3. No hardware will be shipped under this agreement. If it becomes necessary for Analex to ship hardware to CNES, a separate export license will be applied for.

(3) This TAA is to enter into effect on the date of the final signature and is to remain in effect until December 31, 2008.

(4) Technical data will be shared with CNES in France and with their employees in the U.S., mostly if not exclusively at Vandenberg Air Force Base, California and in its vicinity. Analex will deliver on-site support services to CNES' French personnel at Vandenberg or in its vicinity.

II. ITAR Section 124.8

(1) This agreement shall not enter into force, and shall not be amended or extended without the prior written approval of the Department of State of the U.S. Government.

(2) This agreement is subject to all United States laws and regulations relating to exports and to all administrative acts of the U.S. Government pursuant to such laws and regulations.

(3) The parties to this agreement agree that the obligations contained in this agreement shall not affect the performance of any obligations created by prior contracts or subcontracts which the parties may have individually or collectively with the U.S. Government.

(4) No liability will be incurred by or attributed to the U.S. Government in connection with any possible infringement of privately owned patent or proprietary rights, either domestic or foreign, by reason of the U.S. Government's approval of this agreement.

(5) The technical data or defense service exported from the United States in furtherance of this agreement and any defense article which may be produced or manufactured from such

technical data or defense service may not be transferred to a person in a third country or to a national of a third country except as specifically authorized in this agreement unless prior written approval of the Department of State has been obtained.

(6) All provisions in this agreement which refer to the United States Government and the Department of State will remain binding on the parties after the termination of the agreement.

ADDITIONAL TERMS

1. This authorization expires December 31, 2008.

2. Sub-licensing is not authorized.

3. No shipments of hardware, software, technical data, or defense services may take place until such time as the agreement has been executed by all parties. In accordance with 22 CFR 124.4(a), a copy of the signed agreement, revised as may be required by the Department of State, shall be submitted to the Office of Defense Trade Controls within 30 days from the date that it is signed. If a decision is made not to execute the approved agreement, the applicant shall so inform the Office of Defense Trade Controls within 60 days.

4. If the agreement is not executed within one year of the date of this approval, a written report as to the status of the agreement shall be submitted to the Office of Defense Trade Controls on an annual basis until the requirements of 22 CFR 124.4 or 22 CFR 124.5 have been satisfied.

5. Shipment of hardware against this agreement under the provisions of 22 CFR 123.16(b)(1) or by separate license (i.e., DSP-5) is not authorized'. Hardware shipment may take place only after the Department of State approves an amendment to the agreement.

6. The applicant shall not release detailed design data or concepts, design methodology, or manufacturing know-how for the Delta II launch vehicle, components, and ground support equipment. Technical procedures (to include the launch vehicle countdown procedure) that are launch vehicle specific are not authorized for release.

7. The applicant shall not provide any technical assistance to the consignee(s) who might assist the consignee(s) in the design, development; or enhancement of contemplated or existing space systems, launch facilities, or launch processes/operations.

8. All anomaly/problem resolution shall be accomplished strictly by the responsible parties. Collaborative failure analysis with foreign parties is not authorized. Anomaly/non-conformance/failure reports shall be limited to functional block diagrams, top-level descriptions, and drawings/schematics that do not reveal detailed design. Data shall not contain systems engineering processes, techniques, or methodologies.

9. Information on U.S. Government (USG) systems, operations, limitations, or capabilities that is not already in the public domain shall not be offered, discussed, or released.

10. Launch failure analysis or investigation is not authorized under this license. In case of a launch failure, discussions or transfer of any technical data shall be the subject of a separate license submitted for Department of State approval.

11. There shall be no unmonitored or unescorted access to the launch vehicle or any controlled equipment or technical data related to the launch, unless otherwise authorized by a license. Whenever foreign nationals are present, monitoring shall be on a 24-hour basis by U.S. participants throughout launch preparations, satellite mating/demating, test and checkout, launch, and debris recovery.

12. The applicant shall maintain a library of released technical data subject to USG inspection and audit. The cost of DOD participation in any audit performed by the USG is reimbursable to the DOD.

14. Applicant shall provide NASA HQ, Code ID/John F. Hall, Esq., 300 E. Street, SW, Washington, D.C. 20546, with a copy of this Department of State approval memo (license), and signed Technical Assistance Agreement.

15. Applicant understands that NASA-controlled technical data listed in this TAA will be approved for transfer. Transfer of other NASA non-public-domain technical data in support of this TAA requires NASA approval. Applicant will contact Mr. John F. Hall, Esq. for approval (phone: 202-358-2070, fax: 202-358-4080, e-mail: john.f.hall@nasa.gov).

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed effective as of the day and year provided.

Ronald A. Alexander
Export Official
Analex Corporation

Dated: October 29, 2004

Pierre MOSKWA
Directeur du Centre Spatial de Toulouse

8 DEC. 2004

ANNEX A

CALIPSO Memorandum of Understanding (MOU)

Between NASA and CNES

MEMORANDUM OF UNDERSTANDING

BETWEEN

THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OF THE UNITED STATES

AND

THE CENTRE NATIONAL D'ETUDES SPATIALES

OF FRANCE

FOR COOPERATION IN

THE CALIPSO MISSION

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Preamble

The National Aeronautics and Space Administration of the United States (hereinafter referred to as NASA), represented by its Administrator, and

The Centre National d'Etudes Spatiales of France (hereinafter referred to as CNES), as established under the provisions of the Law 61-1382 dated December 19, 1961, setting up a national center for space research, represented by its President,

as the Parties to this Memorandum of Understanding (MOU) (hereinafter the Parties),

CONSIDERING their cooperative effort that led to the successful TOPEX/Poseidon mission launched by an Ariane launch vehicle on August 10, 1992, and their agreement of December 20, 1996, for the Jason-1 program,

RECOGNIZING the need for a mission to collect data to understand better the role of clouds and aerosols in climate, thus improving the ability to predict long term climate change and seasonal to interannual climate variability,

CONSIDERING that such a mission could use light detection and ranging (lidar) technology and applications,

RECALLING the success of the first demonstration of the feasibility of lidar in NASA's Lidar In-Space Technology Experiment (LITE), launched on the STS-64 mission in September 1994,

CONSIDERING their common interest in developing the capacity to use a lidar instrument on a long-term basis to improve the ability to predict long term climate change,

RECALLING that a cloud and aerosol mission was recommended for Phase A study by the CNES science advisory panel (CPS) in March 1998, following the prospective scientific seminar in Arcachon, France,

RECALLING that the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission, including CNES participation, was selected for development in December 1998 by NASA's Earth Science Enterprise through its second Earth System Science Pathfinder (ESSP-2) Announcement of Opportunity (AO), and

RECALLING that in October 1999, the CNES Board of Directors endorsed CNES' participation in the CALIPSO mission,

Have agreed as follows:

Article I - Purpose

This MOU sets forth the terms and conditions under which the Parties will cooperate in the CALIPSO mission.

Article II - Mission Description and Participation

1. The primary objective of the CALIPSO mission is to collect cloud and aerosol data to allow a better understanding of the role of clouds and aerosols in climate and improve the ability to predict long-term climate change and seasonal to interannual climate variability. The Parties will use lidar, infrared radiometry, and visible imaging techniques to satisfy this objective.

2. A secondary objective is to provide a set of simultaneous coincident data with which to validate and improve data retrievals from NASA's Earth Observing System (EOS) Aqua mission. To satisfy this objective, CALIPSO will adapt its orbit to the EOS Aqua orbit.

3. The CloudSat mission, also selected by NASA under the ESSP-2 AO, will fly in formation with CALIPSO, so that the two satellites can simultaneously collect cloud and aerosol data. It is understood between the Parties that the CloudSat mission will adapt its orbit to the CALIPSO orbit, and that the CloudSat mission will neither create a major interference nor a major impact on the CALIPSO mission. Plans are to co-manifest CALIPSO and CloudSat for a dual launch from a U.S. launch site using a NASA-provided Delta II launch vehicle. The CALIPSO satellite will be in the upper position of the dual configuration.

4. CNES also plans to fly its Polarisation et Anisotropie des Réflectances au sommet de l'Atmosphère couplées avec un Satellite d'Observation emportant un Lidar (PARASOL) mission in formation with CALIPSO so that the two satellites can simultaneously collect cloud and aerosol data. PARASOL will adapt its orbit to the CALIPSO orbit and will neither create a major interference nor a major impact on the CALIPSO or the CloudSat mission.

5. For purposes of this MOU, the payload is defined as the module that contains the instruments, the payload onboard computer, payload data storage and telemetry system and the payload structure. The platform is defined as the structure to which the payload is attached. The flight Star Tracker Assembly (STA) is part of the platform, but is mounted onto the payload. The satellite is composed of the assembled payload and platform and is launched into space.

6. The CALIPSO mission is led by NASA. The CALIPSO satellite, integrated and tested under CNES' responsibility, will consist of a platform, designed and provided by CNES, carrying a payload, under NASA's responsibility, containing instruments to be provided by both Parties. The payload instrument complement will consist of an Infrared Imaging Radiometer (IIR), provided by CNES, and a lidar and a Wide-Field Camera (WFC) provided by NASA. Additionally, NASA will provide the storage required and a payload telemetry system to downlink the payload data, the payload onboard computer, and the payload structure. NASA will be responsible for launching the CALIPSO satellite.

7. The Level 1 Requirements document issued by NASA Headquarters describes the baseline mission as the three-channel lidar, the IIR, and the WFC, flying in formation with a broadband flux instrument and a multi-spectral radiometer--such as the Clouds and the Earth Radiant Energy System (CERES) and Moderate Resolution Imaging Spectrometer (MODIS) on Aqua and Terra--and a minimum on-orbit duration of 3 years. This baseline mission has been agreed upon by both Parties.

8. The CALIPSO mission will collect science data and products for clouds and aerosols. For purposes of this MOU, the following definitions will apply. "X-band satellite telemetry" is data as received from the payload, including sensor and housekeeping data. "Payload science data" is the portion of the X-band satellite telemetry composed of the instrument sensor data. "Science data products" are products resulting from the processing of the payload science data.

9. The CALIPSO satellite is planned to operate for a nominal period of three years. The satellite will be operated by CNES throughout the life of the mission. NASA will command and control the payload by providing payload commands to the CNES satellite control center for uplink. NASA will process X-band satellite telemetry, science data and science data products, as defined in Articles IV and XV below. The X-band satellite telemetry, science data and science data products, as required, will be made available to CNES in a timely manner. There may be satellite expendables remaining at the end of the nominal three-year mission and after a reserve for end-of-life disposal has been established. Any residual expendables, above that required to support disposal, can be used to provide extended satellite operations should the Parties decide to support such extension of the CALIPSO mission. After end of mission, the satellite will be passivated and disposed of in accordance with established NASA and CNES procedures as documented in the CALIPSO Project Plan.

10. Payload science data and science data products will be made available to the CALIPSO science team and the broader international user community according to Article XV below.

Article III - CNES Responsibilities

To implement this cooperative project, CNES, in accordance with the detailed provisions of the CALIPSO Project Plan to be developed by the Parties and defined in Article VII, will use reasonable efforts to:

1. Support the overall systems engineering function for the CALIPSO mission, including support in developing overall system specifications and overall Interface Control Documents (ICDs) which define the NASA/CNES interfaces;

2. Provide satellite engineering, develop a satellite specification document and establish requirements for overall satellite level testing, plan and conduct satellite level tests, evaluate test results, certify satellite flight readiness and provide a Payload Design Interface Specification (PDIS) between the platform and the payload;

3. Design, fabricate, assemble, test and calibrate the IIR, provide an IIR simulator for payload interface verification, transport the IIR and IIR simulator to the NASA-designated integration site, and support integration of the IIR onto the payload;

4. Design, fabricate and test the CALIPSO platform (PROTEUS), including the flight STA;

5. Design, fabricate, and transport a mass model of the STA and the STA's flight wire harness to the NASA-designated site;

6. Integrate the payload onto the CALIPSO platform, perform functional and environmental testing, transport the integrated CALIPSO satellite to the NASA-designated launch site in the U.S. and support launch site processing, as detailed in the CALIPSO Project Plan;

7. Support end-to-end system level testing by performing functional tests of the satellite, including assistance with testing of the payload data telemetry system with NASA-provided ground control and data archival centers;

8. Provide ground support equipment and qualified personnel at appropriate sites to support payload and system integration, testing, launch and operations;

9. Provide NASA with all satellite requirements and constraints necessary for satellite launch, and satisfy all launch vehicle requirements and constraints (e.g., safety requirements) unless formally waived;

10. Perform checkout of the CALIPSO satellite during the launch campaign;

11. Operate the satellite, as required, until the end of the in-flight check-out phase, and operate the satellite on a nominal work week schedule during the routine phase;

12. Design, fabricate, and test the Satellite Operations Ground System (SOGS) which includes the Satellite Operations Control Center (SOCC), based on the PROTEUS Generic Ground Segment (PGGS), the data communication network and the TM/TC Earth terminal (TTCET);

13. Receive and provide to NASA S-band data related to the payload and satellite, as specified in the CALIPSO Project Plan;

14. Perform system level testing between the satellite and the SOGS. This system level testing will also include joint testing with the NASA-provided Payload Operations Control Center (POCC);

15. Perform evaluation and calibration activities, as required and mutually agreed, after launch and according to a schedule defined in the CALIPSO Project Plan, to verify the performance achieved on-orbit by the IIR, and provide results to NASA. Perform analysis and validation of IIR telemetry data during the overall mission, with the assistance of the Institut Pierre Simon LaPlace (IPSL), as required;

16. Develop, with the support of IPSL, IIR science data processing algorithms and test cases for coding and implementation by NASA in its Distributed Active Archive Center (DAAC);

17. Arrange with the appropriate French research organizations to support and prepare the French members of the science teams, French scientists and French users to analyze and validate CALIPSO payload science data and science data products and publish their findings in accordance with Articles VI, XV and XVI below; in particular, in archiving and/or making available, as appropriate, CALIPSO science data products to the scientific community;

18. Arrange with the appropriate French research organizations to support IPSL in processing existing payload science data and science data products;

19. Define and implement the French component of the CALIPSO outreach program; and

20. Inform NASA promptly of any technical or programmatic problems, which may affect overall CALIPSO mission schedules, cost or performance.

Article IV - NASA Responsibilities

To implement this cooperative project, NASA, in accordance with the detailed provisions of the CALIPSO Project Plan to be developed by the Parties and defined in Article VII, will use reasonable efforts to:

1. Provide system engineering, develop overall system specifications and overall ICDs which will define the NASA/CNES interfaces, including support of the payload/platform ICD that demonstrates compliance to the PDIS;

2. Provide requirements for overall payload level testing, the planning and conduct of payload system level tests, evaluation of test results and certification of flight readiness;

3. Design, fabricate, assemble and test the payload onboard computer, payload storage and telemetry system and the payload structure;

4. Design, fabricate, test, and calibrate the NASA instruments, consisting of a lidar and a WFC;

5. Provide the information on interfaces of the payload to the IIR;

6. Provide specifications for the Payload Numerical Simulator for incorporation into the CNES PROTEUS Engineering Simulator Test and Operations (PRESTO) bench;

7. Provide attachment fittings on the payload for mounting the CNES-provided STA and integrate the STA flight wire harness;

8. Assemble, integrate, and test the CALIPSO payload;

9. Design, fabricate and test the NASA-provided ground system, the DAAC, the POCC, the Mission Operations Control Center (MOCC) and the Payload Data Delivery System (PDDS);

10. Perform end-to-end system level testing, including system level testing between the payload data telemetry system and the NASA-provided ground system;

11. Transport the payload to the CNES-designated site, in preparation for satellite integration;

12. Provide ground support equipment including a payload simulator and qualified personnel at appropriate sites to support satellite and system integration, testing, launch and operations;

13. Provide launch services for the CALIPSO satellite which are compatible with PROTEUS capabilities and support CNES' check-out of the CALIPSO satellite during the early operations phase (in-flight check-out phase);

14. Provide CNES with all necessary launch vehicle information as defined in the CALIPSO Project Plan and support CNES in verification of the compatibility of satellite/launch vehicle interfaces;

15. Manage the launch campaign, including launch vehicle integration and pre-launch testing;

16. Perform payload operations and mission management;

17. Perform evaluation and calibration activities, as required and mutually agreed, after launch and according to a schedule defined in the CALIPSO Project Plan, to verify the performance achieved on-orbit by the lidar and WFC, and provide results to CNES;

18. Receive, process and archive X-band satellite telemetry and make X-band satellite telemetry, payload science data and science data products available to CNES via the MOCC, POCC, and DAAC, as required, in a timely manner and in accordance with Article XV;

19. Develop, code and implement in the DAAC, the lidar and WFC science data processing algorithms, and code and implement in the DAAC, the IIR algorithms developed by CNES and deliver the operational code to CNES;

20. Support the U.S. science team members in analyzing and validating CALIPSO payload science data and science data products and in publishing their findings, in accordance with Articles VI, XV and XVI below;

21. Define and implement the U.S. component of the CALIPSO outreach program; and

22. Inform CNES promptly of any technical or programmatic problems, which may affect overall CALIPSO schedules, cost, or performance.

Article V - Project and Program Management

1. A CALIPSO Joint Steering Group (JSG) will be established to provide implementation oversight for the mission. The CALIPSO JSG will be composed of senior level NASA and CNES representatives involved in the development of the CALIPSO mission. The JSG will review project implementation status, resolve implementation conflicts, and provide institutional resources to ensure timely delivery of mission elements.

2. The NASA CALIPSO Principal Investigator (PI) will be responsible for overall mission success. The PI will be supported by a Co-PI from Hampton University and a Co-PI from IPSL. Consistent with the guidelines of the NASA Earth System Science Pathfinder program, the CALIPSO Principal Investigator (PI) has delegated mission implementation responsibility to the CALIPSO Mission Management Team (MMT). The CALIPSO MMT will provide end-to-end mission planning and day-to-day management, and will serve as an interface to the JSG. The MMT will be composed of the NASA CALIPSO Project Manager, the NASA CALIPSO Mission Manager, and the CNES Deputy CALIPSO Project Manager.

Article VI - Science Team and International Science Advisory Panel

1. Science Team

The science team, formed by the NASA CALIPSO PI, will be responsible for the science management of the CALIPSO mission. The Co- PIs from Hampton University and IPSL are members of the science team. The science team may also include other U.S. and non-U.S. scientists, including scientists selected by CNES. Proposed science team members will be agreed to by the PI and Co-PIs and approved by the NASA Associate Administrator for Earth Science.

The CALIPSO science team will be the principal scientific forum for instrument oversight, algorithm development, validation of science data, and initial science data evaluation studies. Additionally, the science team may select scientists with an expertise in the area, to perform science data evaluation. The Parties reserve the right to establish guest investigator programs for validation and science data evaluation studies.

The CALIPSO PI, supported by the Co-PIs, will be responsible for the development of the scientific aspects of CALIPSO and for assuring that the science data products are effectively used and that the results are expeditiously produced and made available, according to Article XV below. They will also be responsible for coordinating science requirements, plans and field experiments with other organizations.

2. International Science Advisory Panel (ISAP)

An ISAP, headed by the Co-PI from Hampton University will be established to provide advice on the science goals of the CALIPSO program, provide an independent assessment of its scientific progress, expand the usefulness and application of its science data products, and provide a vehicle

for broad international collaboration. The ISAP will be composed of four to seven eminent atmospheric scientists, who will represent the CALIPSO data user community and who will be selected by the Co-PI from Hampton University, in consultation with the NASA CALIPSO PI and the Co-PI from IPSL.

Article VII - Project Plan

1. The NASA CALIPSO Project Manager will prepare, in close coordination with the CNES Deputy Project Manager, a CALIPSO Project Plan, which will then be subject to approval by the Parties. In case of conflict between the CALIPSO Project Plan and this MOU, the MOU will prevail. This plan will detail how this cooperative project will be carried out, including mission planning, provision of the satellite, instruments and ground systems, description of interfaces, conduct of mission operations (including end of mission disposal) and data delivery, overall delivery schedule, plan for formal and informal reviews, process and configuration control, delivery timelines for X-band satellite telemetry, payload science data and science data products, and other such information as the NASA CALIPSO Project Manager and CNES Deputy Project Manager deem necessary for project control.

2. To ensure mission success, NASA and CNES will provide mutual insight into the elements under their respective responsibility, consistent with Article XIII of this MOU. Details of the insight to be provided will be described in the Project Plan.

3. Meetings and reviews required to carry out the responsibilities set forth in this MOU will also be included in the CALIPSO Project Plan, and will be held periodically in the United States, France and at other sites as mutually agreed. The schedule, scope and responsibilities of technical and programmatic reviews will be defined in the CALIPSO Project Plan. These reviews will be chaired by NASA and/or CNES, as appropriate. The Parties agree to always invite each other to these meetings and reviews.

4. The Parties will use reasonable efforts to carry out their respective responsibilities in accordance with the schedules to be defined in the CALIPSO Project Plan, and to avoid changes that will have a negative effect on the other Party with regard to scientific return, implementation approach, cost, and/or schedule, and where they cannot be avoided, to minimize these negative effects. To the extent that changes made by NASA or CNES to the CALIPSO Project Plan cause schedule, or other problems that go beyond either Party's program constraints, the MMT will discuss potential options to address such problems, and submit their proposals to the JSG for approval.

Article VIII – Mission Reviews, Integration and Flight Readiness

1. To implement the CALIPSO mission, there will be a series of mission reviews to evaluate the readiness of the flight and ground segments to proceed to implementation, integration, test, and final launch preparation. Representatives from both Parties will serve on the boards of these

reviews. Both Parties will furnish engineering and programmatic data and will participate in these mission reviews, as mutually agreed. All mission review details will be included in the CALIPSO Project Plan.

2. NASA and CNES will jointly:
   Make a final determination of the overall readiness to proceed with integration of the platform and the payload;
   Make a final determination on the readiness of the satellite for integration with the launch vehicle; and
   Make a final determination of the overall readiness of the CALIPSO satellite for launch.

Article IX - Exchange of Personnel

To facilitate coordination related to the CALIPSO mission, the Parties will support the exchange of a limited number of liaisons from each Party, at a time and under conditions as mutually agreed by the NASA CALIPSO Project Manager and CNES Deputy Project Manager pursuant to necessary administrative authorizations. In the event of such an exchange, the Parties each will provide necessary office space and administrative support at the host location, including such additional support services as may be agreed by the NASA CALIPSO Project Manager and CNES Deputy Project Manager. Salary and all other personnel expenses, living and travel expenses, will be borne by the employing Party of the liaison(s) throughout the duration of their assignment.

Article X - Funding

Each Party will bear the costs of discharging its respective responsibilities under this MOU, including travel and subsistence of each Party's personnel and transportation of its own equipment and associated documentation. The obligations of the Parties under this MOU are subject to their respective funding procedures and the availability of appropriated funds.

Article XI - Customs and Taxes

Each Party will use reasonable efforts to arrange free customs clearance and waiver of applicable duties and taxes for equipment and related goods necessary for the implementation of this MOU. Such arrangements will be fully reciprocal. In the event that any customs fees and/or taxes of any kind are still levied on the equipment and related goods for implementation of this MOU, after seeking to develop the necessary free customs clearance and waiver of applicable duties and taxes, such customs fees and/or taxes will be borne by the Party of the country levying the fees and/or taxes.

Article XII - Ownership of Elements and Equipment

For the purposes of this MOU, each Party will retain ownership of elements and equipment it furnishes to the other Party. Any equipment not launched into space will be returned to the furnishing Party at such time as mutually agreed. Each Party will transport its equipment to the designated delivery points, as specified in the CALIPSO Project Plan, and, where appropriate, from such delivery points, when the equipment is to be returned to the furnishing Party.

Article XIII - Exchange of Technical Data and Goods

The Parties are obligated to transfer only those technical data (including software) and goods necessary to fulfill their respective responsibilities under this MOU, in accordance with the following provisions:

1. The transfer of technical data for the purpose of discharging the Parties' responsibilities with regard to interface, integration, and safety will normally be made without restriction, except as required by national laws and regulations relating to export control or the control of classified data. If design, manufacturing, and processing data, and associated software, which is proprietary but not export controlled, is necessary for interface, integration, or safety purposes, the transfer will be made and the data and associated software will be appropriately marked. Nothing in this article requires the Parties to transfer goods or technical data contrary to national laws and regulations relating to export control or control of classified data.

2. All transfers of proprietary technical data and export-controlled goods and technical data are subject to the following provisions. In the event a Party finds it necessary to transfer goods which are subject to export control or technical data which is proprietary or subject to export controls, and for which protection is to be maintained, such goods will be specifically identified and such technical data will be marked with a notice to indicate that they will be used and disclosed by the receiving Party and its related entities (e.g., contractors and subcontractors) only for the purposes of fulfilling the receiving Party's responsibilities under the programs implemented by this MOU and that the identified goods and marked technical data will not be disclosed or retransferred to any other entity without the prior written permission of the furnishing Party. The receiving Party agrees to abide by the terms of the notice, and to protect any such identified goods and marked technical data from unauthorized use and disclosure, and also agrees to obtain these same obligations from its related entities prior to the transfer.

3. All goods, marked proprietary data, and marked or unmarked technical data subject to export control, which are transferred under this MOU, will be used by the receiving Party exclusively for the purposes of the programs implemented by this MOU.

Article XIV - Invention, Patent and Intellectual Property Rights

1. In the event that an invention is jointly made by employees of the Parties, their contractors or subcontractors, during the implementation of this agreement, the Parties will consult and agree as to the responsibilities and costs of actions to be taken to establish and maintain patent protection for such invention and on the terms and conditions of any license or other rights to be exchanged or granted by or between the Parties.

2. Nothing in this MOU will be construed as granting or implying any rights to, or interest in, patents owned or inventions which are independently developed by the Parties or their contractors or subcontractors.

Article XV – Science Data Policy

Access to CALIPSO science data will be as follows:

1. In all cases, the Parties will provide immediate access to all CALIPSO payload science data and science data products, free of charge, for members of the science team, as well as designated representatives of science team members, including associates, staff and co-workers. The Parties will also provide free of charge, payload science data and science data products necessary to the scientists selected for validation.

2. NASA has the responsibility to make science data products available to the public and the science community in a Hierarchical Data Format (HDF)-standard data format after the appropriate science calibration and validation, at no more than the cost of fulfilling the user request. In order to promote rapid access to science data products, some preliminary science data products will be archived after initial verification, but prior to full validation, and made available to all users at no more than the cost of fulfilling the user request.

3. All X-band satellite telemetry, payload science data and science data products obtained from the CALIPSO mission will be archived in appropriate NASA data centers as defined in the CALIPSO Project Plan. Copies of the CALIPSO science data products will be exchanged between the Parties.

4. The CALIPSO science team members (including designated representatives) and scientists selected for validation must provide a report to the Parties on the results of their analysis and validation investigations.

5. All users, including the CALIPSO science team members and scientists selected for validation, should provide a report to the Parties on the results of their investigations on validated CALIPSO science data.

6. Notwithstanding any termination of this MOU by either Party, any X-band satellite telemetry and science data products obtained from the CALIPSO mission, as defined in the

CALIPSO Project Plan, will be archived by NASA for at least 10 years after completion of the CALIPSO mission, unless otherwise agreed by the Parties.

7. The Parties will provide mutual access to science data products from their separate, but related missions, EOS-Aqua, CloudSat and PARASOL. The Parties will agree on the terms of data access. If deemed of interest for scientific analysis of CALIPSO data, the Parties may agree to provide mutual access to correlative data products from other missions.

8. To enhance scientific analysis of CALIPSO data, coordinated Announcements of Opportunity may be issued by the Parties.

Article XVI - Publication of Public Information and Results

The Parties retain the right to release public information regarding their own activities under this MOU. The Parties will coordinate with each other in advance concerning public information activities, which relate to the other Party's responsibilities or performance under this MOU.

The analyzed results obtained from the CALIPSO mission will be made available to the general scientific community through publication in appropriate journals or presentations at scientific conferences as soon as possible and consistent with good scientific practices. In the event that such reports or publications are copyrighted, the Parties will have a royalty free right under the copyright to reproduce, distribute and use such copyrighted work for their own purposes.

In the event a Party or its investigators publish results primarily obtained from CALIPSO science data, or other information regarding results obtained from the implementation of this MOU, the Party or its investigators involved with the publication will make this information available to the other Party, and each Party will, at minimum, have a royalty free right to reproduce, use, and distribute the publication for its own purposes.

In no event will a Party include in a publication export controlled or proprietary technical data or information on technical goods furnished by the other Party, in accordance with Article XIII of this MOU, or information disclosing the other Party's inventions before patent application, without the other Party's prior written consent.

Article XVII – Liability

(a) The purpose of this Article is to establish a cross-waiver of liability between the Parties and their related entities in the interest of encouraging participation in the exploration, exploitation, and use of outer space. This cross-waiver of liability will be broadly construed to achieve this objective.

(b) As used in this cross-waiver,

(1) the term "Related Entity" means:

(i) a contractor or subcontractor of a Party at any tier;
(ii) a user or customer of a Party at any tier; or
(iii) a contractor or subcontractor of a user or customer of a Party at any tier. "Contractors" and "subcontractors" include suppliers of any kind.

(2) the term "damage" means:

(i) bodily injury to, or other impairment of health of, or death of, any person;
(ii) damage to, loss of, or loss of use of any property;
(iii) loss of revenue or profits; or
(iv) other direct, indirect, or consequential damage.

(3) The term "payload" means any property to be flown or used on or in the launch vehicle.

(4) The term "launch vehicle" means an object or any part thereof intended for launch, launched from Earth, or returning to Earth which carries payloads or persons, or both.

(5) The term "Protected Space Operations" means all launch vehicle and payload activities on Earth, in outer space, or in transit between Earth and outer space done in implementation of this MOU. Protected Space Operations begins upon entry into force of this MOU and ends when all activities done in implementation of this MOU are completed. It includes, but is not limited to:

(i) research, design, development, test, manufacture, assembly, integration, operation, disposal, or use of launch or transfer vehicles, payloads, or instruments, as well as related support equipment and facilities and services;

(ii) all activities related to ground support, test, training, simulation, or guidance and control equipment and related facilities or services. "Protected Space Operations" excludes activities on Earth which are conducted on return from space to develop further a payload's product or process for use other than for launch vehicle-related activities necessary to complete implementation of this MOU.

(c) (1) Each Party agrees to a cross-waiver of liability pursuant to which each Party waives all claims against any of the entities or persons listed in sub-paragraphs (c)(1)(i) through (c)(1)(iii) of this section based on damage arising out of Protected Space Operations. This cross-waiver will apply only if the person, entity, or property causing the damage is involved in Protected Space Operations and the person, entity, or property damaged is damaged by virtue of its involvement in Protected Space Operations. The cross-waiver will apply to any claims for damage, whatever the legal basis for such claims, against:

(i) the other Party;
(ii) a related entity of the other Party;
(iii) the employees of any of the entities identified in sub-paragraphs (i) and (ii) above.

(2) In addition, each Party will extend the cross-waiver of liability as set forth in paragraph (c)(1) of this section to its own related entities by requiring them, by contract or otherwise, to agree to waive all claims against the entities or persons identified in sub-paragraphs (c)(1)(i) through (c)(1)(iii) of this section.

(3) For avoidance of doubt, this cross-waiver of liability includes a cross-waiver of liability arising from the Convention on International Liability for Damage Caused by Space Objects of March 29, 1972, where the person, entity, or property causing the damage is involved in Protected Space Operations and the person, entity, or property damaged is damaged by virtue of its involvement in Protected Space Operations.

(4) Notwithstanding the other provisions of this Article, this cross-waiver of liability will not be applicable to the following:

(i) claims between a Party and its own related entity or between its own related entities;
(ii) claims made by a natural person, his/her estate, survivors, or subrogees for bodily injury, other impairment of health or death of such natural person, except where the subrogee is a Party to this MOU or has otherwise agreed to be bound by the promises of this cross-waiver;
(iii) claims for damage caused by willful misconduct;
(iv) intellectual property claims;
(v) contract claims between the Parties based on the express contractual provisions of this MOU; or
(vi) claims for damage based on a failure of the Parties or their related entities to flow down the cross-waiver.

(5) Nothing in this Article will be construed to create the basis for a claim or suit where none would otherwise exist.

Article XVIII- Registration of Space Objects

CNES will request that the Government of France register the CALIPSO satellite as a space object in accordance with the Convention on Registration of Space Objects Launched into Outer Space of January 14, 1975. Registration pursuant to this section will not affect the rights or obligations of either Party or its Government under the 1972 Convention on International Liability for Damage Caused by Space Objects.

Article XIX – Settlement of Disputes

Any dispute not settled through the mechanisms provided in Article V, or any other issue concerning the interpretation or implementation of the terms of this MOU that cannot be resolved otherwise, will be referred to the appropriate level of management of the Parties for consideration and action.

Article XX - Entry into Force, Duration, Amendment and Termination

This MOU will enter into force upon signature and remain in force until five years after the CALIPSO satellite has been launched. This MOU may be amended and extended by written agreement of the Parties. Either Party may terminate this MOU at any time upon twelve months written notice to the other Party. In that event, the Parties will endeavor to reach agreement on terms and conditions to minimize negative impacts of such termination on other Parties.

Termination of this MOU will not affect a Party's continuing obligations under Articles V, XIII, XIV, XV, XVI, and XVII of this agreement concerning Project and Program Management; Exchange of Technical Data and Goods; Invention, Patent and Intellectual Property Rights; Science Data Policy; Publication of Public Information and Results; and Liability, unless otherwise agreed by the Parties.

Done, in duplicate, in the English and French languages, both texts being equally authentic.

Signed at: Paris, France

Date: June 18, 2003

__Sean O'Keefe_____
FOR THE NATIONAL
AERONAUTICS AND
SPACE ADMINISTRATION
OF THE UNITED STATES

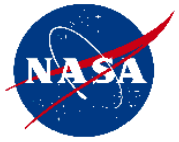
Signed at: Paris, France

Date: June 18, 2003

_Yannick d'Escatha_____
FOR THE CENTRE
NATIONAL D'ETUDES
SPATIALES OF FRANCE

ANNEX B

CNES/NASA Calipso Project Plan



National **A**eronautics and **S**pace **A**dministration
Langley Research Center

Centre **N**ational d'Etudes **S**patiales

- Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations -

(CALIPSO)

NASA/CNES CALIPSO PROJECT PLAN

	Date	Signature
Prepared by: J. Rogers B. Belon		
Approved by: D. Winker M. Pircher J. Newsom		

Revision Record					
REV	**Date**	**Author**	**Approval**	**Description**	**Pages Affected**
	28-Feb-01	J. Rogers B. Belon		Initial Release	ALL
2.0	2 May 2002	J. Rogers B.Belon		New version approved by CCB Change Request CCR-008	ALL
??	Mar '03	J. Rogers B.Belon		……..	……..

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1 *INTRODUCTION*

1.1 BACKGROUND

In April 1998, the Office of Earth Sciences (OES) at NASA Headquarters released the second Earth System Science Pathfinder (ESSP-2) Program Announcement of Opportunity (AO). The ESSP Program's intention was to initiate low cost, quick turn-around missions to accomplish high quality, focused Earth System Science measurements utilizing innovative, streamlined management and implementation approaches designed to yield high value science.

Both NASA and CNES recognized a unique opportunity to develop a mission of mutual interest which fit the above OES criteria and which had as a science objective, to collect data to better understand the role of clouds and aerosols in climate.

A joint proposal, *Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO*)[1] mission, was submitted in response to the AO and after rigorous competition, was selected for development in December 1998 by NASA's Earth Science Enterprise.

NASA and CNES entered into an interim agreement on July 12, 1999, which covers pre-Phase B and Phase B CALIPSO activities.

On the 6th October 1999, the CNES Board of Directors endorsed CNES' participation in the CALIPSO mission.

A Memorandum Of Understanding (MOU) has been agreed upon by NASA and CNES and is to be signed 2003. The MOU defines general responsibilities and the terms and conditions under which both agencies agree to cooperate in the CALIPSO Mission. Much of the international cooperation established during the proposal was based upon previous successful joint missions, namely the TOPEX/Poseidon mission launched in August 1992 and the follow-on Jason-1 mission.

1.2 PURPOSE AND SCOPE

In accordance with the Memorandum Of Understanding (MOU) between NASA and CNES, the Project Plan defines the means by which NASA in the U.S. and CNES in France shall jointly act in cooperation to execute the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) mission.

The Project Plan is a mutual NASA/CNES plan for developing the systems which support the space, launch, ground, and science segments for the CALIPSO Mission. This plan defines how this cooperative project will be implemented, including:

- mission management (responsibilities, reviews, configuration control, documentation, actions management, confidentiality, schedule management),

[1] Program name at time of selection was Pathfinder Instruments for Cloud and Aerosol Spaceborne Observations (PICASSO-CENA). Name officially changed to CALIPSO Nov 5, 2001

- reciprocal products deliveries and management of their interfaces (launcher, satellite, payload, instruments, ground systems),
- mission operations (responsibilities, data deliveries),
- and other such information as the NASA Project Manager and CNES Project Manager deem necessary for project control.

1.3 MISSION SCIENCE OBJECTIVES

The mission science objective is to collect new information on clouds and aerosols from an orbiting platform to allow improved understanding of climate and climate change. Climate models now predict a significant global warming in response to rising concentrations of carbon dioxide and other greenhouse gases in the atmosphere. However, confidence in these predictions is low because of significant uncertainties in the representations of key physical processes in these models. The predictive capability of climate models must be improved to enable policy makers to reach balanced decisions on potential mitigation strategies. Recent scientific assessments by the Intergovernmental Panel on Climate Change (IPCC), the National Research Council (NRC), and the report of a recent external advisory panel to NASA all came to the same conclusion: the largest uncertainties in our ability to predict future climate change are associated with the radiative effects of aerosols and clouds. Focused global measurements of aerosols and clouds are required to improve predictive capability. These necessary measurements are not provided by present spaceborne missions.

The CALIPSO mission provides these crucial measurements in a timely and cost-effective manner. The payload combines a 3-channel lidar with two carefully selected passive sensors—Wide Field Camera (WFC), and Imaging Infrared Radiometer (IIR)—to obtain unique data on aerosol and cloud vertical structure and optical properties. The CALIPSO satellite will fly in formation with Aqua to produce a coincident, 3-year, global data set that is essential for accurate quantification of aerosol and cloud radiative effects. CloudSat, another ESSP mission, will fly for two years in formation with CALIPSO to produce complementary science data for cloud structure, physical properties, and their effects on climate. PARASOL, the microsatellite mission recently approved by the CNES Scientific Advisory Committee, will fly in formation with CALIPSO to produce a complementary data set to CALIPSO, Aqua, and CloudSat. These four satellites together with the NASA Aura Satellite are referred to as the “afternoon constellation”.

1.4 SCIENCE AND MISSION REQUIREMENTS

The Level-1 mission requirements for CALIPSO are established in the Level-1 Requirements Document issued by NASA Headquarters. The Level-1 science requirements for the CALIPSO mission and instruments are described in the SMRD (PC-SYS-101).

1.5 BASELINE MISSION

As agreed in the MOU, the science objectives will be achieved by flying the lidar, the Imaging Infrared Radiometer (IIR), and a wide field camera (WFC) in formation with Aqua for a three-year mission life. Science requirements can still be met if the IIR and/or WFC are operated discontinuously during the third year of the on-orbit mission to meet power constraints, if required

1.6 SCIENCE PRODUCTS

Requirements for the science products, including the desired measurements, the necessary ranges and accuracies of the measurements, the means and durations of data transference, and near term archiving are defined in the SMRD (PC-SYS-101).

Management of the science data, including collection, processing, archiving, and dissemination is described in the Data Management Plan (PC-SCI-502). Information on the data product content and format is contained in the Data Products Catalog (PC-SCI-503).

1.7 APPLICABLE DOCUMENTS

The CALIPSO MOU between NASA and CNES (noted above) is the overarching document to which this Project Plan is responsive and is the authority to prevail should there occur conflicts within or with the interpretation of this document. Other applicable documents are shown in Table 1-1 below and are responsive to the Project Plan.

Table 1-1: Applicable Documents (AD)

Document No.	***Document Title***
AD01	Memorandum Of Understanding Between the National Aeronautics and Space Administration of the United States And the Centre National d'Etudes Spatiales of France for Cooperation in CALIPSO Mission
PC-SYS-101/AD02	CALIPSO Science and Mission Requirements Document (SMRD)
PC-SYS-102/AD03	CALIPSO Segments Requirements Document (SRD)
PC-SYS-103/AD04	CALIPSO Mission Operations Concept Document
PC-SYS-801/AD05	CALIPSO Deliverable Item list
PC-SYS-804/AD06	CALIPSO Documents List
PC-PRJ-509/AD07	CALIPSO Configuration Management Plan

2 *MISSION CONSTRAINTS, POLICIES, AND GUIDELINES*

The following constraints, policies, and guidelines are levied on the CALIPSO mission:

a. The CALIPSO Mission is to be accomplished as proposed, and as directed by Dr. Ghassem Asrar's selection letter of December 22, 1999 to Dr. David Winker and in compliance with the ESSP-2 AO. Thus, Level 1 changes to the proposed science objectives, instruments/measurements, mission design, team membership, management approaches, and cost or schedule require approval of the NASA Headquarters Associate Administrator for Earth Sciences and impacts must be coordinated with CNES in accordance with the NASA/CNES MOU and as outlined in Section 8 herein.

b. The CALIPSO Mission is to be accomplished as proposed, as defined by Mr. Brachet's decision of March 8,2000.

c. The Memorandum Of Understanding co-signed by the NASA Administrator and CNES President define the general responsibilities of NASA and CNES and the terms and conditions under which they have agreed to cooperate in the CALIPSO Mission.

d. The direction by the Headquarters Earth Sciences Associate Administrator for the co-manifested launch of the CALIPSO and CloudSat missions, on a launch vehicle of the Delta-II type and subsequent formation flying of the two satellites.

e. The use of the generic PROTEUS platform as the satellite platform with minimized adaptations.

f. The use of the PROTEUS generic ground segment (Control center and one earth terminal) adapted to CALIPSO.

g. The use for Infrared Sensor Modules (ISM's) of IASI Infra Red cameras design, with minimized adaptations

h. The satellite to be launched 2004.

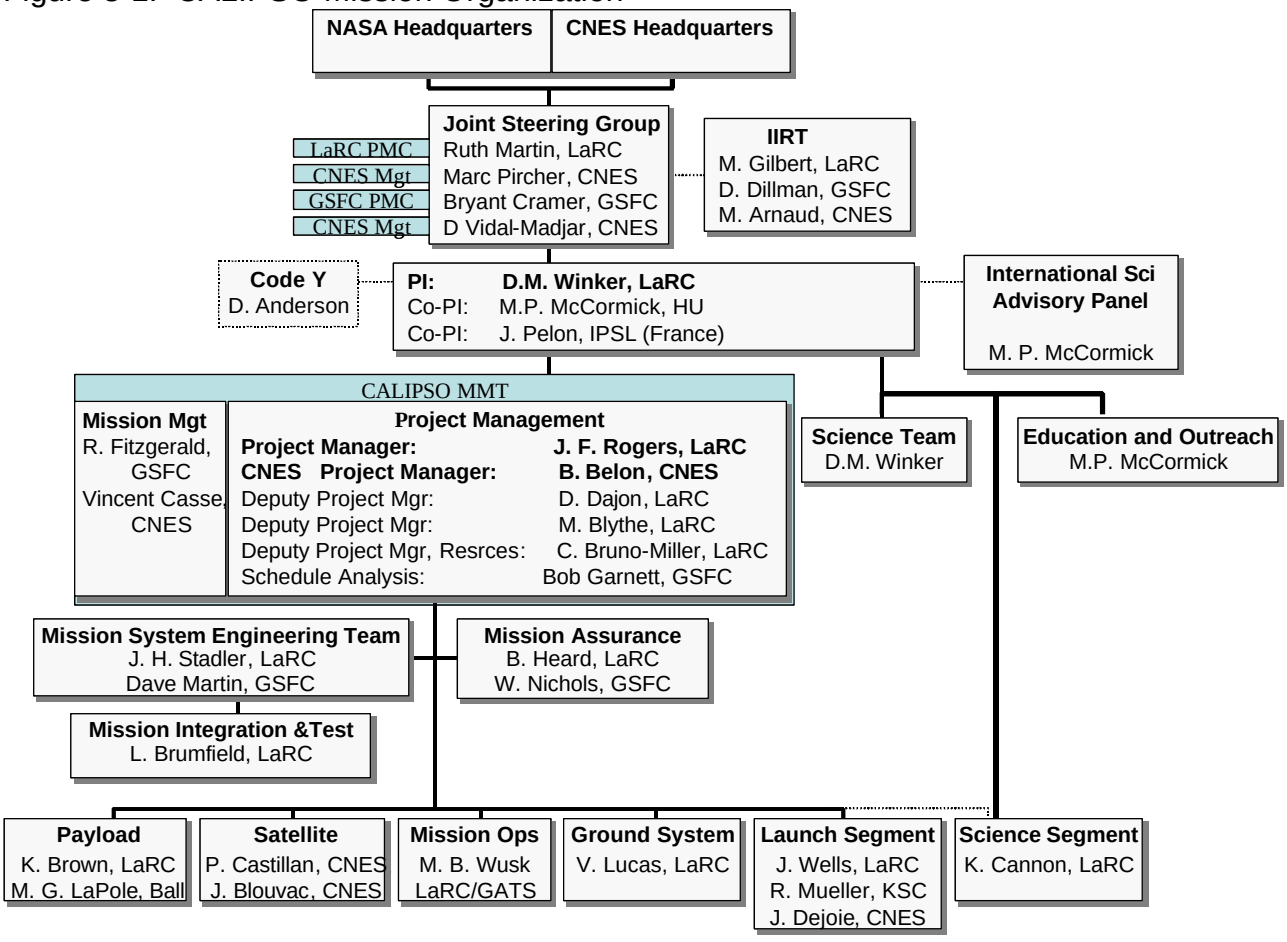
i. All transfers of proprietary technical data and export-controlled goods and technical data as specified in the NASA/CNES MOU, Article XIII.

3 *MISSION MANAGEMENT*

3.1 MISSION ORGANIZATION

The mission organization includes the NASA Langley Research Center (LaRC)/Goddard Space Flight Center (GSFC), the French Centre National D'Etudes Spatiales (CNES), Hampton University (HU), the Institut Pierre Simon Laplace (IPSL), and Ball Aerospace and Technologies Corporation (Ball). The Mission Organization with roles and responsibilities is led by Dr. David Winker of LaRC and is shown below in Figure 3-1.

Figure 3-1: CALIPSO Mission Organization



GSFC is responsible for Mission Management, LaRC is responsible for Mission Science Integrity, Project Management, Systems Engineering, Mission Assurance, and Payload Operations; Ball is responsible for developing the Payload and Payload Data Downlink System; CNES is responsible for satellite engineering, PROTEUS Platform procurement, and for conducting Satellite Operations; Hampton University is responsible for education and outreach and algorithm implementation, and IPSL is responsible for leading the French science activities. Kennedy Space Center (KSC) will provide launch services

under agreement with LaRC. LaRC and CNES team member detailed responsibilities are outlined in chapter 5, “Products Identification and Implementation Responsibilities.” Specific responsibilities for GSFC team members are as follows:

Systems Engineer:

- Supports LaRC Systems Engineer in performing Mission Systems Engineering Functions. Specific duties include:
  - Serve as the GSFC technical coordinator for engineering support to the project
  - Maintains the Mission Verification Plan
  - Updates and maintains the DOORS requirements database
  - Supports HFS/BV2 testing and Payload arrival and integration in France

Quality Assurance Specialist:

- Supports the LaRC Mission Assurance Manager by:
  - Participation in Payload Test Readiness Reviews to ensure that the test procedures and equipment are approved and ready
  - Witness of Payload inspection and cleaning processes
  - Witness of Payload packaging and shipping preparations
  - Witness of Payload receipt and post-shipment check-out at the Satellite Integration & Test Facility and the launch site
  - Providing Quality Assurance and safety oversight at Ball Aerospace, Alcatel, and VAFB

Schedule Analyst:

- Works with LaRC Scheduler to maintain overall project schedule and develop monthly status reporting
  - Assists in project schedule variance analysis and project slack analysis
  - Assists in developing new formats to track schedule progress more closely
  - Assists in maintenance and tracking of project milestones

Business Manager/Resources:

- Supports LaRC Business Manager in budget analysis and reporting
  - Reviews monthly 533 reporting and other financial information
  - Develops monthly financial charts to support GSFC MSR
  - Coordinates funding management and transfer

Systems Assurance Manager:

- Works collaboratively with LaRC Mission Assurance Manager
- Coordinates activities of GSFC Quality Assurance Specialist
- Coordinates use of GSFC Code 300 resources as needed to support the Mission

Flight Software Engineer:

- Supports LaRC Mission Software Manager in software process review and reporting

Safety Engineer:

- Leads GSFC safety assessment
- Provides input to GSFC Code 300, LaRC and the project

Mission Design Analyst:

- Supports LaRC Systems Engineer in performing and reviewing mission design analyses

3.2 JOINT STEERING GROUP

As stated in the MOU, the Joint Steering Group (JSG) provides implementation oversight for the mission. The CALIPSO JSG will be composed of senior level NASA and CNES representatives involved in the development of the CALIPSO mission. The JSG will review project implementation status, resolve implementation conflicts, and provide institutional resources to ensure timely delivery of mission elements.. The JSG will consist of three members including the CNES Orbital Systems Director (co-chair), theNASA GSFC CALIPSO Program Manager (co-chair), and the NASA LaRC Associate Director for Program Integration. and may include additional representatives as agreed upon by the co-chairs.

3.3 MISSION MANAGEMENT TEAM (MMT)

The NASA CALIPSO Principal Investigator (PI) is responsible for overall mission success. The PI has delegated mission implementation responsibility to the MMT. The MMT will provide end-to-end mission planning and day-to-day management, and will serve as the project interface to the JSG. The MMT will be composed of the NASA CALIPSO Project Manager, the CNES CALIPSO Project Manager, and the NASA CALIPSO Mission Manager.

3.4 PROJECT KEY PERSONNEL

The key personnel for the CALIPSO Mission are listed below.

Changes in key personnel will be approved by the respective organizations with consent by NASA as prescribed by the partnering/contractual agreements.

- Principal Investigator (NASA): Dave Winker
- Co-Principal Investigator (IPSL): Jacques Pelon
- Co-Principal Investigator (Hampton University): M. Pat McCormick
- Mission Manager (NASA): Rick Fitzgerald
- Project Manager (NASA): John Rogers
- Project Manager (CNES): Bruno Belon
- Deputy Project Manager (NASA): Debra Dajon

- Deputy Project Manager (NASA): Mike Blythe
- Deputy Project Manager for Resources (NASA): Cindy Bruno-Miller
- Payload Program Manager (Ball): Mark LaPole
- Mission Systems Engineer (NASA): John Stadler
- Deputy Mission Systems Engineer (NASA): Dave Martin
- Launch Segment Manager (NASA): Jim Wells
- Space System Manager (CNES): Patrick Castillan
- Satellite Manager (CNES): Jean Blouvac
- Payload- Platform Interface manager (CNES): Pierric Ferrier
- Payload Implementation Manager (NASA): Alan Little
- Satellite-Launcher Interface manager (CNES): Joel Dejoie
- Ground Segment Manager (NASA): Victor Lucas
- Mission Operations Manager (NASA): Mary Beth Wusk
- Science Segment Manager (NASA): Kim Cannon
- Platform System Manager (CNES): Jean Blouvac
- Payload Manager (NASA): Kevin Brown
- Payload Systems Engineer (NASA): David Rosenbaum
- SOGS Manager (CNES): Paul Gelie
- Operations Manager (CNES): Philippe Crebassol
- MOGS Manager (NASA): Mary Beth Wusk
- NASA Data Manager (NASA): Chris Currey
- French Science Data System Manager (CNES): Anne Lifermann
- IIR Manager (CNES): Thierry Bret-Dibat
- Mission Integration and Test Manager (NASA): Larry Brumfield
- Mission Software Manager (NASA): Bob Estes
- Mission Assurance Manager (NASA): Brent Heard
- Mission Software Quality Assurance Manager (NASA): Leslie Johnson
- Mission Assurance Manager – Satellite (CNES): Christian Martin
- Configuration Manager LaRC: Dimitri Solga
- Configuration Manager CNES Christiane Bringel

Alan Little (NASA) and Pierric Ferrier (CNES) are part time residents respectively and alternatively at CNES and LaRC; as such, they are in charge of NASA-CNES communications facilitating for all NASA-CNES interface topics.

3.5 INTEGRATED TEAMS

In order to improve communication and efficiency between NASA and CNES teams, integrated teams are put in place at Mission and at Satellite level.

The Mission Integrated Team organization is defined in Appendix 3

The Satellite Integrated Team organization is defined in Appendix 4

4 *MISSION AND FLIGHT SYSTEMS DESCRIPTION*

4.1 MISSION (FOR INFORMATION)

The Mission objectives, top level requirements and constraints are defined in the “Science and Mission Requirements Document” (SMRD) (AD 02).

CALIPSO is a mission designed to provide global measurements of aerosols and clouds required for a better understanding of the role of aerosols and clouds in the climate system and to improve our abilities to predict long term climate change and seasonal-to-inter-annual climate variability. The mission has four objectives: 1) Provide a global suite of measurements from which the first *observationally-based* estimates of direct aerosol forcing, and its uncertainty, can be made; 2) Enable the first global *observationally-based* assessment of indirect aerosol radiative forcing; 3) Improve the accuracy of satellite estimates of longwave radiative fluxes at the surface of the Earth and longwave heating rates within the atmosphere by a factor of 2; and 4) Provide a new ability to assess cloud feedback in the climate system, including thin cirrus, polar clouds, and multi-layered cloud systems, all of which are poorly determined by passive radiometers alone. To meet these objectives, the payload combines a 3-channel lidar with a Wide Field Camera (WFC), and Imaging Infrared Radiometer (IIR) to obtain unique data on aerosol and cloud vertical structure and optical properties.

The CALIPSO satellite is to be co-manifested with CloudSat on a Delta II launch vehicle and launched to a quasi sun-synchronous orbit such that it flies in formation with Aqua satellite.

The instruments of the satellite are a three channel lidar, which provides altitude profiles, and two instruments which provide images: the infra-red imaging radiometer (IIR) and the visible wide-field camera (WFC). CloudSat and PARASOL will fly in formation and adapt their orbit to CALIPSO.

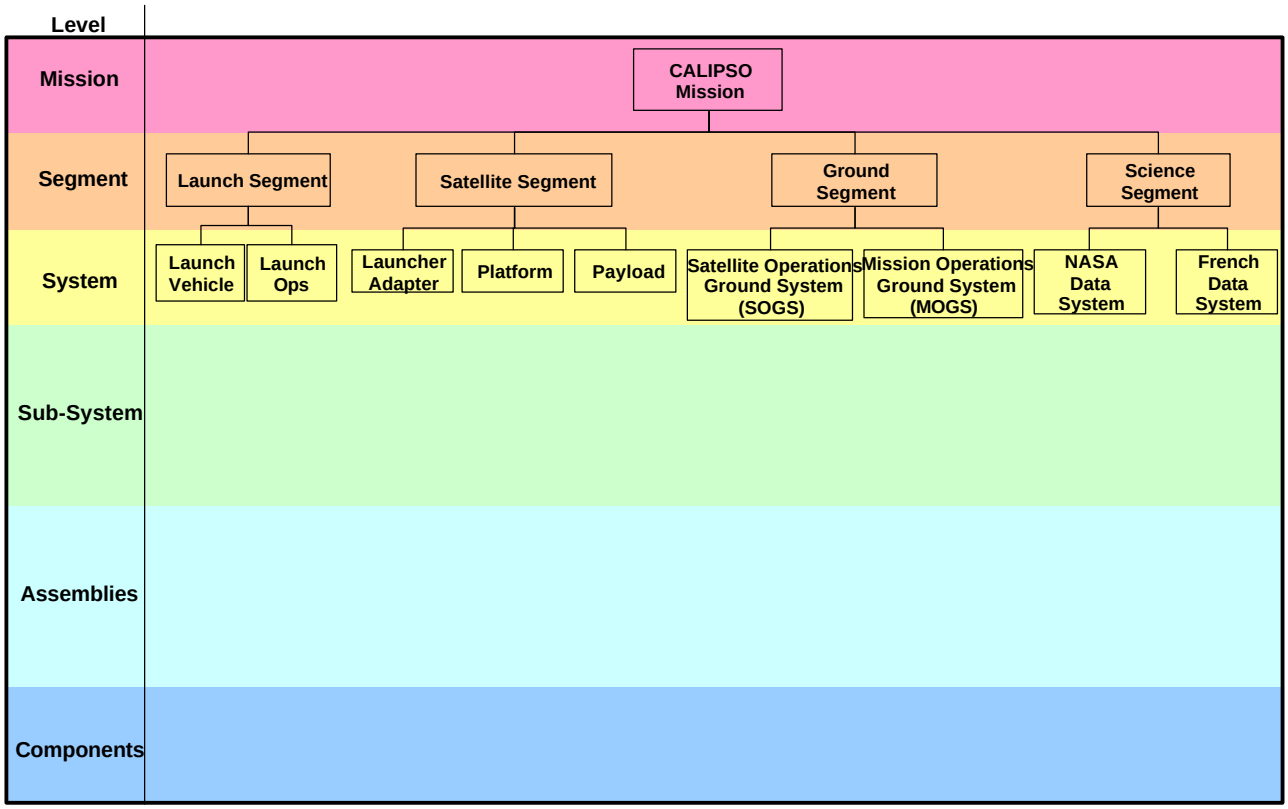
Science data sets will consist of: aerosol and cloud vertical distributions; aerosol extinction, optical depth, and single scattering albedo; cloud extinction, optical depth, and emissivity; Cirrus asymmetry parameter and effective particle size; and surface and atmospheric radiative fluxes.

4.2 SYSTEM ARCHITECTURE (FOR INFORMATION)

The system architecture and requirements are defined in the “Segments Requirements Document” (SRD) (AD03).

The CALIPSO architecture is structured in a top-down succession of levels: Mission level, segments, systems, subsystems, assemblies, and components as shown in Figure 4-1.

Figure 4-1: CALIPSO Mission Architecture



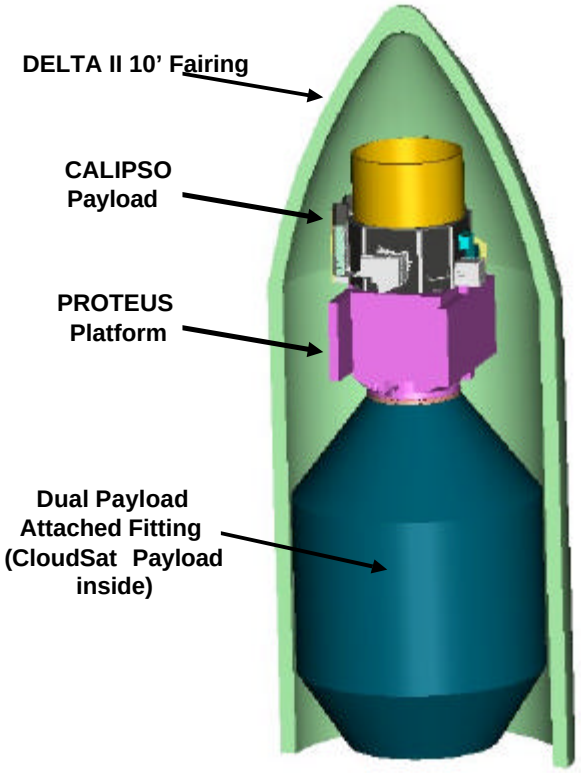
4.2.1 Launch Segment

The launch is manifested by NASA HQ Flight Planning Board. The launch service is managed through Kennedy Space Center's Expendable Launch Vehicle Program via the Med-Lite contract. The launch vehicle segment includes the launch vehicle and the associated launch preparation and operations.

4.2.1.1 Launch Vehicle

The CALIPSO satellite will be launched on a Delta II 7420 – 10 Launch Vehicle in a Dual Launch Configuration with CloudSat. CALIPSO will occupy the upper berth of the Dual Payload Attach Fitting (DPAF) on the Delta II and CloudSat will occupy the lower berth as shown in Figure 4-2.

Figure 4-2: Launch Vehicle DPAF Configuration



4.2.1.2 Launch Operations

Launch Operations will be conducted at Vandenberg Air Force Base primarily using services provided through the Med-Lite contract. Operations will include satellite testing, satellite integration, launch range support, and launch.

4.2.2 Satellite Segment

The satellite includes the platform, the payload and the launcher adapter as shown in Figure 4-3.

Figure 4-3: CALIPSO Satellite

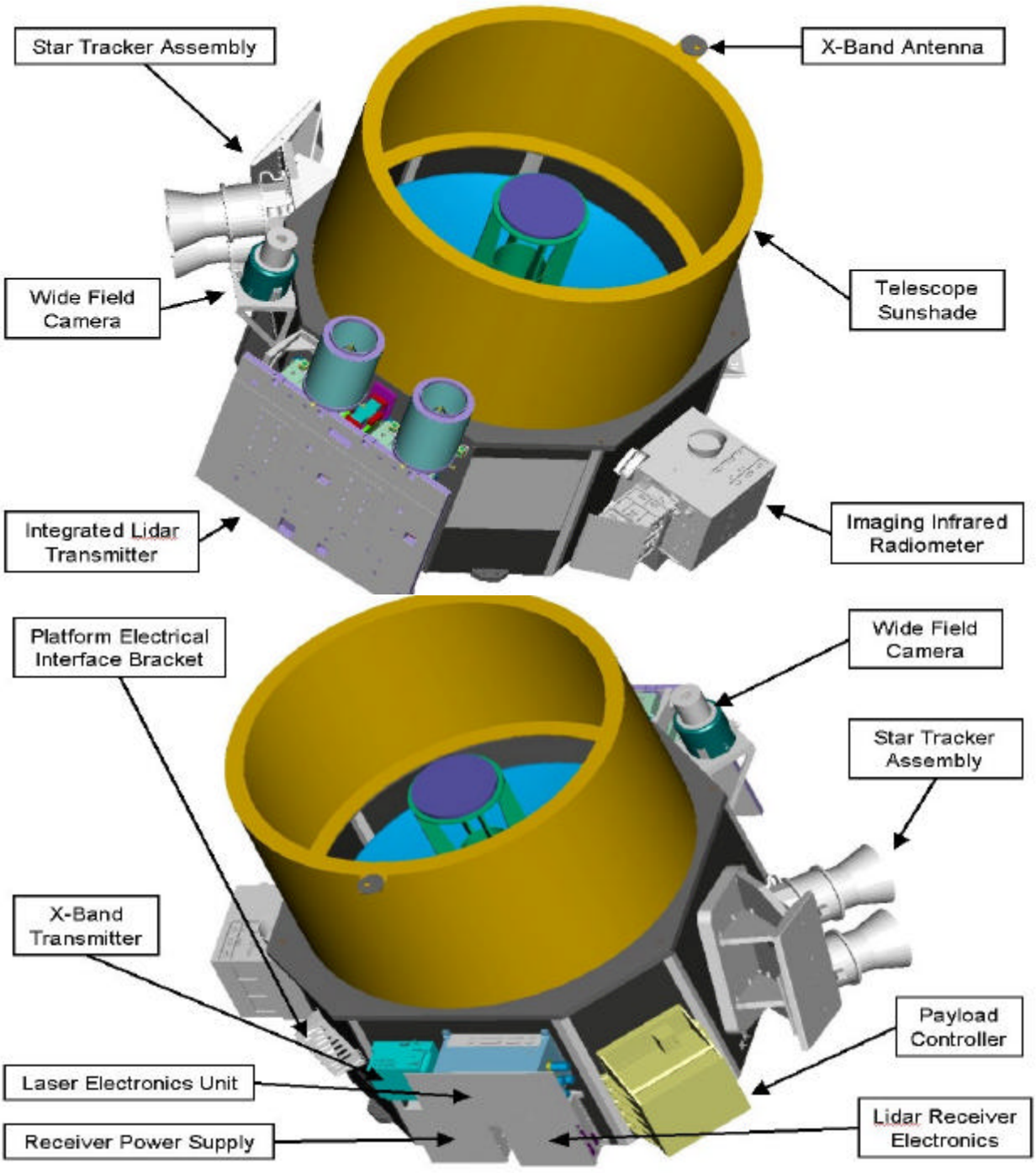
4.2.2.1 Platform

CALIPSO utilizes an Alcatel PROTEUS Platform. The Platform provides the satellite power, attitude control, orbit station keeping, command and control, and S-band up-link and downlink telemetry and telecommand. Additionally, the Platform provides the Payload with discrete and analog channels, which can be monitored on-orbit by the Platform or on the ground. Although the Payload and the Platform are required to be thermally isolated, the Platform provides coarse thermal control to the Payload. Additionally, the Platform provides the following data to the Payload via the Mil-Std-1553B bus: Satellite GPS data, Satellite attitude data, and Time.

4.2.2.2 Payload

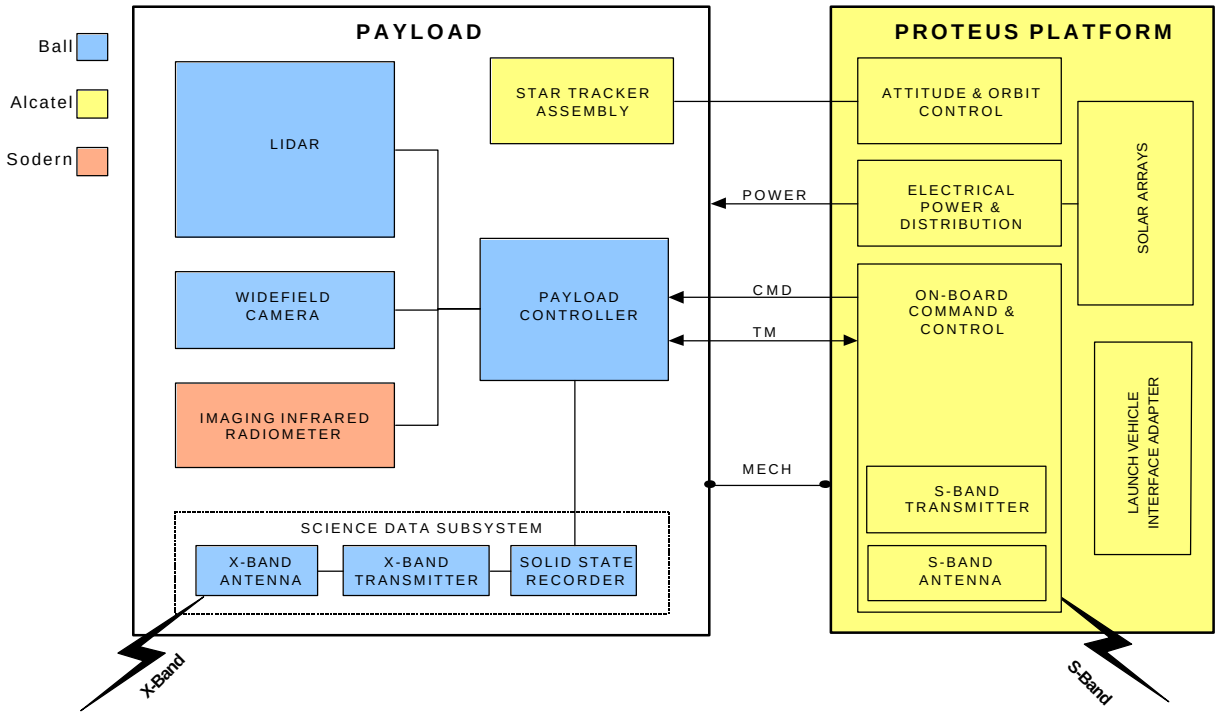
The CALIPSO Payload consists of the suite of three science instruments (lidar, WFC, and IIR), the science data subsystem (SDS), the Payload controller, and the Payload structure. The Payload's data volume exceeds the Platforms S-Band telemetry bandwidth capability. Therefore, the Payload has its own science data storage and downlink subsystem, which consists of a Solid State Recorder (SSR) and an X-band downlink system. The Payload controller collects data from the instruments, commands and controls the Payload, and communicates with the Platform via a MIL-STD-1553B bus.

Figure 4-4: CALIPSO Payload Configuration



The functional breakout of the satellite platform and payload systems and sub-systems and the primary providers are shown in Figure 4-5.

Figure 4-5: Satellite Functional Breakout by System and Provider



The CALIPSO platform is developed under CNES contracts with Alcatel. It will be a protoflight, the qualification of the generic PROTEUS platform being acquired through the PROTEUS program, including the first satellite (Jason) development.

The satellite engineering and AIT is performed under CNES responsibility by CNES and Alcatel under CNES contract.

The CALIPSO Payload is developed under a NASA contract to Ball.

The fully qualified Payload is provided by NASA to CNES for mating to the platform and satellite assembly, integration and environmental testing (AIT).

One of the payload instruments, the IIR, is developed and calibrated by SODERN under CNES contracts.

4.2.3 Ground Segment

The Ground Segment is a distributed segment utilizing NASA, CNES and other resources. It is composed of the SOGS and the MOGS. An overview of the ground segment operation is presented in Figure 4-6.

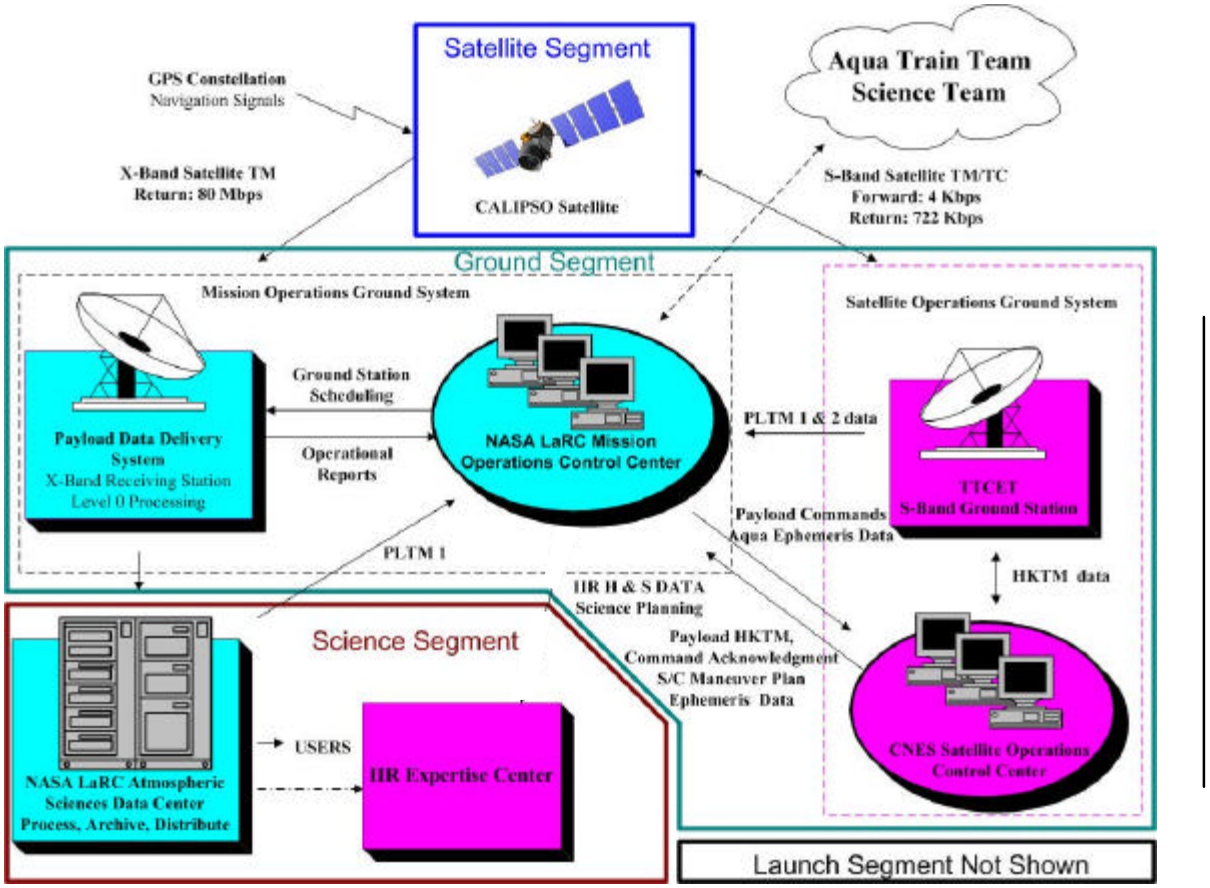


Figure 4-6: CALIPSO Operational Concept Diagram

4.2.3.1 SOGS

The SOGS, located in France, comprises three major sub-systems: the Satellite Operations Control Center (SOCC), the S-Band ground station (TTCET); and the Data Control Network (DCN).

- The SOCC serves as the satellite control center via the S-band telemetry system. Due to similar design requirements, the CALIPSO SOCC will take advantage of the more complex ground system already developed by the JASON project.
- The TTCET S-Band Ground Station supports S-Band command and telemetry functions.

- The DCN provides communication between the SOCC, the S-band ground station, and the internet link to the Mission Operations Control Center (MOCC) in the United States.

The Platform will transmit (either automatically on pre-programmed ground commands or upon ground request) satellite and critical Payload status/health information to the SOCC as required for satellite monitoring. During the Assessment Phase, the SOCC will be staffed as required up to 7 days a week, 24 hours per day. During the Observation Phase, the SOCC will be staffed during a nominal workweek. The SOCC will nominally transmit Platform and Payload commands to the satellite once per week, but provides commanding capability up to four times daily, seven days a week (under anomalous conditions).

The SOGS is developed, validated and operated by CNES

4.2.3.2 MOGS

The Mission Operations Ground System (MOGS), located in the United States, is developed, validated and operated by NASA. It is comprised of two major sub-systems: the Payload Data Delivery System (PDDS) and the Mission Operations Control Center (MOCC).

- The PDDS includes the commercial X-Band Ground Station, the Level 0 processing facility, and the networks required to transfer the data to the Distributed Active Archive Center (DAAC).
- The MOCC will serve as the mission operations control center receiving information from both the X-Band and S-Band telemetry systems, and generating and transferring Payload command builds to the SOCC. The MOCC will autonomously monitor the health and status of the Payload, and perform initial processing of the Payload telemetry data. The MOGS and SOGS will communicate via the standard FTP protocol.

Operational Status: During assessment phase, the MOCC will be manned as required up to 7 days per week, 24 hour per day. During normal operations phase, the MOCC will be manned nominally with on-call support as required. The MOCC will generate the payload commands once per week to be uplinked to the satellite.

4.2.4 Science Segment

The two system components of the Science Segment are the NASA Data System and the French Data System. The Science Segment entails algorithm development and implementation, instrument validation, and data processing, archival, and distribution.

4.2.4.1 NASA Data System: Distributed Active Archive Center

The NASA Data System is the LaRC Distributed Active Archive Center (DAAC) now called the Atmospheric Sciences Data Center (ASDC). The DAAC will perform all science data processing, data archival, and data distribution. Primary data inputs to the DAAC are listed in Table 4-1.

Table 4-1: Data Inputs to the DAAC

Data	Source	Frequency
Level 0 data files (one per instrument) and Health & Status data files	Payload Data Delivery System (PDDS)	Every X-band ground station contact
Quality Control files (one per APID)	Payload Data Delivery System (PDDS)	Every X-band ground station contact
Meteorological Data	GSFC Data Assimilation Office (DAO)	Daily
Ephemeris and Attitude Data	CNES	Daily

The DAAC will process CALIPSO data using the Langley TRMM and Terra Information System (LATIS). All production software, instrument data, and spacecraft ephemeris and attitude data will be processed using the EOSDIS Core System (ECS) science data processing Toolkit. The production schedule for science data products generated by the DAAC is listed in Table 4-2. CALIPSO data products are defined in the Data Products Catalog(PC-SCI-503). The processed data, as well as the raw level 0 data, will be permanently archived at the DAAC. The DAAC will distribute the science data to members of the CALIPSO Science Team at no charge and to all other users for no more than the cost of distribution.

Table 4-2: DAAC Science Data Production Schedule

Level	Data	Production Schedule
1b	Calibrated sensor data	Two-day lag, following completion of the on-orbit checkout.
2a	Lidar backscatter profiles Layer heights/thickness	Preliminary release 135 days after launch, archived after two-year validation period. Data produced on three-day lag thereafter.
2b	Aerosol and Cloud properties	Archived after eighteen month validation period. Data produced on three-day lag thereafter.
4	Surface and atmospheric radiative fluxes	Processed monthly with a 45-day lag.

4.2.4.2 French Data System

The French data system includes the IIR Image Quality Center and the IPSL Scientific Expertise Center in France. The IIR Image Quality Center, located at CNES in Toulouse, will develop IIR Level 1 algorithms, will provide IIR instrument calibration, and IIR instrument health monitoring. The IPSL Scientific Expertise Center, will develop IIR Level 2 algorithms, provide information on IIR instrument performance, and archive, distribute, and process CALIPSO Science data for the needs of the French Scientific Community.

4.2.4.3 Science Algorithms

Science Algorithms will be developed by the Lidar, WFC, and IIR Science Working Groups (SWGs) and will be documented in Algorithm Theoretical Basis Documents (ATBDs) for implementation by LaRC and HU . The Data Management Team will work closely with the SWGs to ensure accurate coding of the algorithms. The SWGs will develop and provide simulated instrument data to the Data Management Team in order to test operational code.

4.2.4.4 Science Data Processing, Archival, and Distribution

The Science Data Processing and Distribution functions are defined in the Data Management Plan (PC-SCI-502).

4.2.4.5 Validation

The On-orbit correlative Validation program is defined in the Science Validation Plan (PC-SCI-501).

4.3 FLIGHT OPERATIONS/PHASES

The operational strategies, roles and responsibilities, team makeup, and concept of CALIPSO mission operations are defined in the Mission Operations Concept Document (MOCD, PC-SYS-103) (AD04).

The primary goal of CALIPSO is to provide data to support U.S., French and international Earth science research. Mission operations will manage the satellite and the ground system to provide good data to the science/user community while remaining within the constraints of available resources. The CALIPSO satellite will collect continuous science data. Stored science data is transmitted via X-band telemetry. Payload and Platform health and status data is transmitted via S-band telemetry. Command loads are transmitted by the S-Band Ground Station.

The 36-month baseline CALIPSO mission is divided into the following five major phases, as defined in the SRD (DA3) and in the MOCD (DA4):

(1) Ground Phase : from integration to launcher ignition

(2) Launch Phase: till satellite separation

(3) Assessment Phase: till satellite in-flight acceptance

(4) Observational Phase: operational phase, includes science (data collection) and non-science (satellite orbit maintenance , non nominal operations), till stop of science operations

(5) End-of-Life Phase: after ceasing science operations (deorbit..)

4.3.1 Flight Operations Roles & Responsibilities

During Assessment Phase, CNES is in charge of conducting the flight operations with the support of NASA.

During Observational Phase, NASA is in charge of conducting the flight operations with the support of CNES.

NASA is primarily responsible for overall coordination of the operations during the observational phase, the operation of the payload, of the MOGS, and the US science data system. CNES is primarily responsible for overall coordination of the operations during the assessment phase, the operation of the satellite (this includes maneuver planning and execution), the SOGS, and the French science data system. The PI, Co-PI's, and the science team are ultimately responsible for the development of the requirements for formation flying.

The CNES Satellite Command & Control Team and the NASA Mission & Payload Operations Team comprise the Flight Operations Team.

Mission & Payload Operations Team (NASA)

The Mission & Payload Operations team is responsible for operation of the MOCC and the PDDS. To reduce cost, operations are conducted during a normal workweek (eight hours per day, five days per week). Additional staffing support will be provided during the assessment phase and during contingency operations. On-call after hours support will be provided with notification via pager. The primary responsibilities of the NASA Mission & Payload Operations Team are:

- Coordinate overall mission operations during observational phase
- Interface with external support facilities to coordinate mission operations
- Plan and schedule payload activities
- Monitor payload health, status, and performance
- Generate payload command builds
- Maintain onboard payload software
- Ensure valid science data is collected and delivered to the DAAC for processing
- Maintain daily operational continuity at the MOCC
- Perform contingency operations as needed

Satellite Command & Control Team (CNES)

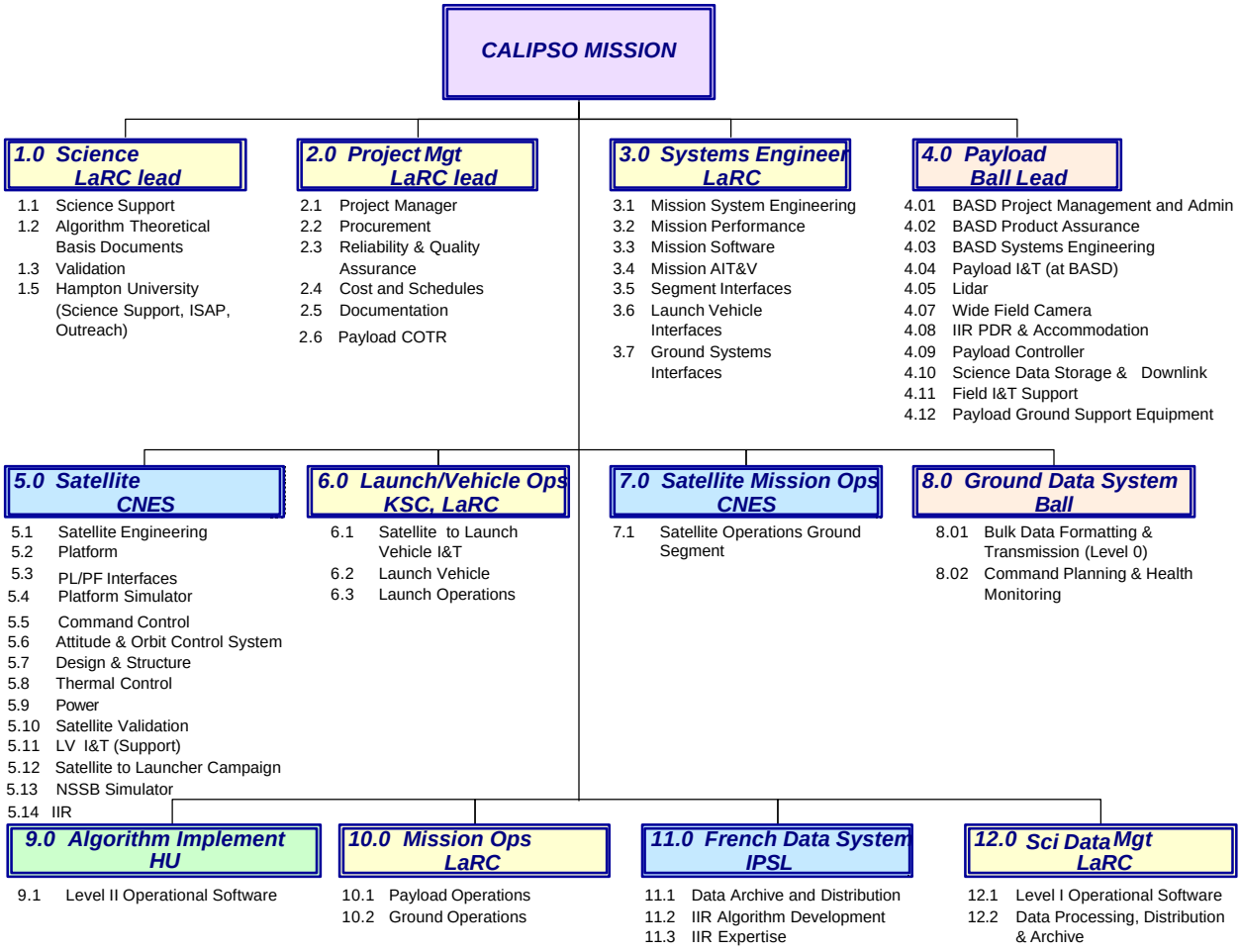
The Satellite Command & Control team is responsible for operation of the SOCC, TTCET, and the DCN. To reduce cost, operations are conducted during a normal workweek (eight hours per day, five days per week). Additional staffing support will be provided during the assessment phase and during contingency operations. On-call after hours support is not planned. (no operational personnel available at the control center during off-peak hours :nights, week-ends, legal holidays, etc.) The primary responsibilities of the CNES Satellite Command & Control Team are:

- Coordinate overall mission operations during assessment phase
- Interface with external support facilities to coordinate satellite operations
- Plan and schedule satellite activities, including maneuvers
- Monitor platform health, status, and performance
- Generate platform command builds
- Maintain onboard platform software
- Uplink the satellite Commands
- Receive and distribute the S-Band telemetry data
- Maintain daily operational continuity at the SOCC
- Perform contingency operations as needed
- Perform orbit determination
- Perform the Proteus Engineering Simulator for Test and Operations (PRESTO)

5 *PRODUCTS: IDENTIFICATION, IMPLEMENTATION RESPONSIBILITIES, AND MAIT*

The product tree follows the Mission Architecture given in Figure 4-1. It is listed below by Agency responsibility, followed by a table describing specific implementation responsibilities. These responsibilities are consistent with CNES and NASA Responsibilities as identified in the NASA/CNES MOU. The products are numbered according to the Mission Work Breakdown Structure (WBS) given below in Figure 5-1. Detailed product trees (segment level) are presented in Appendix 2.

Figure 5-1: Mission Work Breakdown Structure



5.1 PRODUCT IDENTIFICATION AND RESPONSIBILITIES

Table 5-1 defines the products, the applicable numbering of all the products in accordance with the WBS in Figure 5-1, responsibility for the product, and the actual provider.

The column labeled “AGENCIES LEVEL RESPONSIBILITIES” refers to the responsibilities outlined in the NASA/CNES MOU. The Contractor or Provider is the effective provider (writing documents, providing hardware, providing services) of segment, system, or product.

Table 5-1: Product Identification and Responsibilities

PRODUCT	AGENCIES LEVEL RESPONSIBILITY	CONTRACTOR, or PROVIDER
0. Mission Level: CALIPSO Mission	NASA	NASA, LaRC
6 Launch Segment	NASA	NASA, KSC
6.2 Launch Vehicle	NASA	BOEING
6.3 Launch Ops	NASA	NASA, KSC
5 Satellite Segment	CNES	CNES
5.2 Platform	CNES	ALCATEL
5.11 Launcher I/F	CNES	ALCATEL
5.12 PRESTO	CNES	CNES
4.0 Payload	NASA	BALL
4.05 LIDAR	NASA	BALL
4.07 WFC	NASA	BALL
4.09 P/L Controller	NASA	BALL
4.10 Science Data Subsystem	NASA	BALL
4.12 Payload Simulator	NASA	BALL
4.20 IIR	CNES	SODERN
10 Ground Segment	NASA	NASA, LaRC
7.0 Satellite Operations Ground System (SOGS)	CNES	CNES
10.2 Mission Operations Ground System (MOGS)	NASA	NASA, LaRC/BALL
1 Science Segment	NASA	NASA, LaRC
12.0 NASA Data System	NASA	NASA. LaRC
11.0 French Data System	CNES	CNES

PRODUCT	AGENCIES LEVEL RESPONSIBILITY	CONTRACTOR, or PROVIDER
11.2 Scientific Expertise Center	CNES	IPSL
11.3 Technical Expertise Center	CNES	CNES

The specific implementation responsibilities for the mission elements and products are shown in Table 5-2.

TABLE 5-2: IMPLEMENTATION RESPONSIBILITIES

Project level	NASA	- Lead science management - Lead project management - Lead Mission assurance
	CNES	- Support NASA Project & science management - Support NASA mission assurance - Lead science management (French part) - Lead project management (French part) - Lead Mission Assurance (French part)
Mission level	NASA	- lead Mission system engineering
	CNES	- support Mission system engineering
Launch	NASA	– provide contractual interface between the project and the launcher authority – commit for the launcher information & performance – manage the launch campaign – provide launch site facility – provide launcher – provide launcher operations – provide to the satellite in Alcatel a test PAF for dynamical and separation tests – provide to the satellite in Alcatel the Flight PAF for Fit Check

	CNES	- provide technical interface between the satellite and the launcher authority under NASA LaRC contractual responsibility - commit for the satellite information & performance - provide satellite operations on the launch site facility
SATELLITE (see note at the end of the table)	CNES	- lead satellite management - provide satellite engineering - provide the platform - provide payload to platform assembly - provide satellite AIT & functional validation - support the mission level tests - provide to NASA a STA mass model and its Flight wire harness - mount the STA to Payload with Ball support at Alcatel - ship the satellite to launch site
	NASA	- lead payload management - provide payload system engineering - provide the qualified payload to CNES at Alcatel - provide the payload simulator - support satellite AIT (Payload part) - support satellite operations on the launch site (payload part) - support the STA integration onto the Payload at Alcatel - support mission level tests (payload part)

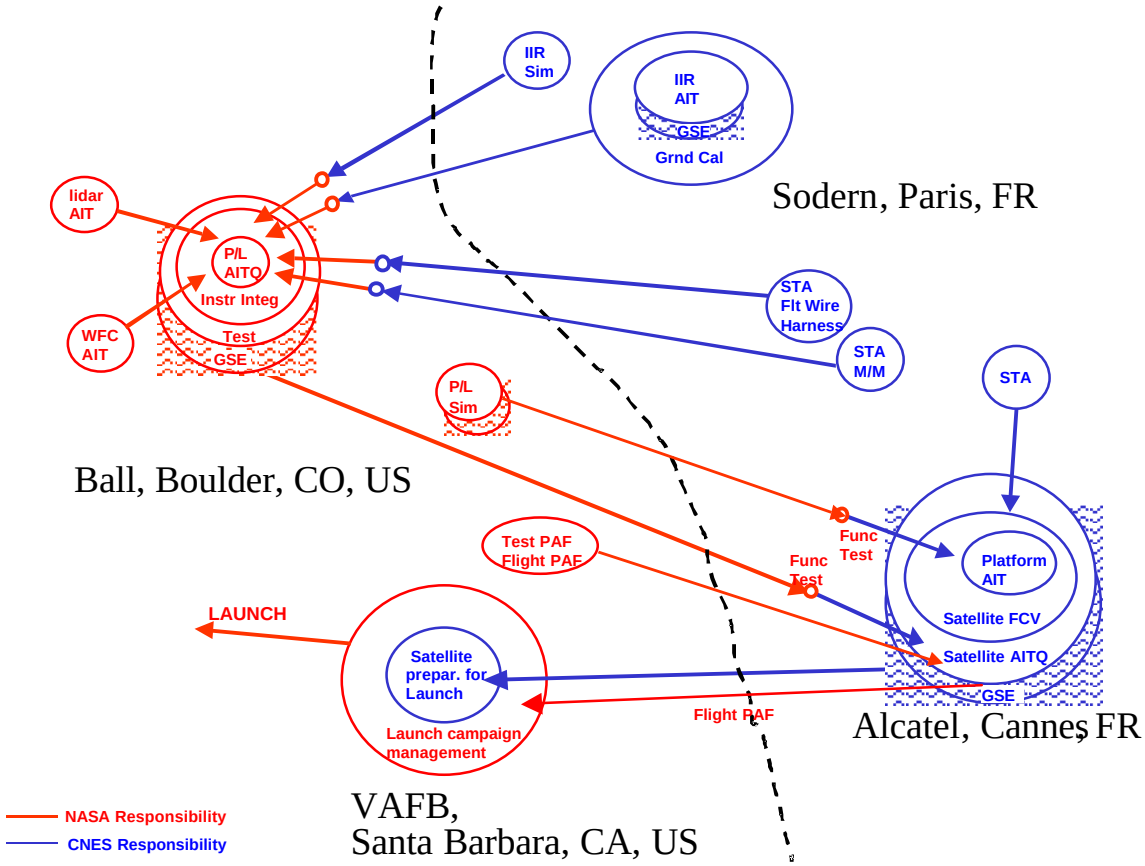
IIR	CNES	- provide the qualified and calibrated IIR - ship the IIR to Ball - provide the IIR simulator to NASA at Ball
	NASA	- manage the IIR/Payload interfaces - develop the IIR mass model - integrate the IIR on the payload
Ground Segment	NASA	- lead ground segment management
	CNES	- support Ground segment management
Satellite Operations Ground System (SOGS)	CNES	- - provide the SOGS - design, fabricate & operate the Presto
	NASA	- *provide Payload Workstations to mirror POCC Workstations for Payload Health & Status Data, Visualization and Command Generation (at CNES) (TBC)*
Mission Operations Ground System (MOGS)	NASA	- provide MOGS
Science segment	NASA LaRC	Lead science segment management- Develop and operate NASA Science Data System Develop the LIDAR and WFC Algorithms - Implement the instrument operational software (including the IIR operational software) - Process all instrument data and make results available to the French Science Data System - Provide a copy of the IIR algorithms operational source software to CNES/IPSL
	CNES	- Develop and operate French Science Data System - Develop the IIR prototype algorithms

RF Frequencies	NASA	- Manage X-Band frequencies regulations topics
	CNES	- Manage S-Band frequencies regulations topics
Mission Operations	NASA	- lead observational phase mission operations - perform Payload commanding and operation - support on-orbit check out
	CNES	- lead assessment phase mission operations - lead satellite operations - perform satellite commanding and operation - provide satellite data telemetry system - lead on-orbit check out

Note: Satellite responsibility definition: The satellite responsibility (CNES responsibility) is related to all that concerns the development, the qualification and the performance of the satellite, except the payload scientific functions (instruments management, instruments measurements, science data management).

Figure 5-2 is a graphical representation describing the responsibilities in Table 5-2 for product exchange related to the satellite: simulators, hardware , flight models, and other GSE.

Figure 5-2: Satellite Product Exchanges



5.2 ASSEMBLY, INTEGRATION, AND TEST

The Assembly, Integration and Test activities follow the general responsibility sharing of the project:

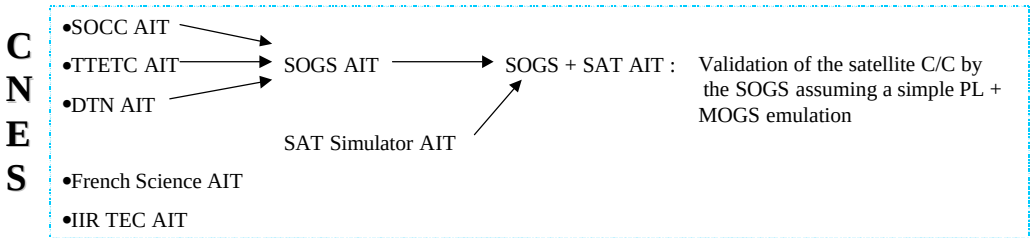
- Mission level NASA
- Launcher NASA
- Satellite CNES
- Platform CNES
- Payload NASA
- PL parts except IIR NASA
- IIR CNES
- Ground Segment NASA
- SOGS CNES

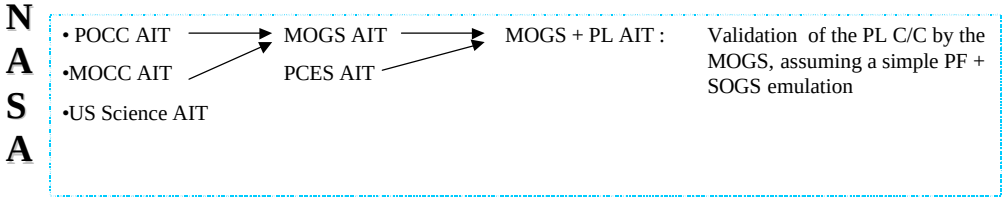
- MOGS NASA
- Science Segment NASA
- NASA data system NASA
- French data system CNES

Each level is in charge of its own validation and of the validation of the interfaces between the parts that compose this level, assuming each part is already validated .

The sequence and responsibilities of the assembly, integration and test of the system is defined by the following schemes:

1 - Elementary - Agency Level- :





2 - INTERFACES

- MOGS + SOGS AIT ↖ NASA + CNES
- MOGS + US Science AIT ↖ NASA
- MOGS + IIR TEC AIT ↖ NASA + CNES
- US Science + French Science AIT ↖ NASA + CNES

3 - END TO END TESTS

	Tests for Assessment Phase	Tests for Operational Phase
MOGS + SOGS +SAT	**CNES + NASA**	**NASA + CNES**
SAT +MOGS + US Science	X	**NASA + CNES**
Whole system : MOGS + SOGS+SAT+US Science + F Science + IIR TEC	. X	**NASA + CNES**

The launcher-satellite interface is dealt in a particular manner: the technical validation of the interface is managed directly by CNES and launcher authority, under NASA/LaRC contractual leadership.

The responsibilities for AIT are also depicted in the next chapter through documentation responsibilities (validation plans and test reports).

6 *DOCUMENTATION*

The overall documentation of the project is defined in the CALIPSO Document List (PC-SYS-804), AD06. This list contains all documents' critical information-- title, document number, configuration control level, description, predecessor, successor, approving organization, delivering organization, responsible person, receiving organization, version, expected date of delivery for delivering organization, expected date of receipt by receiving organization, and actual delivery date. This document follows the configuration control rules.

This chapter addresses major documents which relate to the NASA-CNES cooperative efforts.

6.1 AGENCIES AGREEMENT

Title	Prepared by	Approved by	Concurred by	Released by
MOU	PI, CNES Program Manager, Project Managers	NASA Administrator & CNES President		

6.2 MANAGEMENT DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
NASA-CNES Project Plan	NASA & CNES Project Managers	PI, LaRC Management & CNES Management		
Project Schedule	Project Managers	Project Managers	Mission System Manager and Segment Managers	
Configuration Management Plan	Configuration Manager	Project Managers		
Mission Assurance Documents	Mission Assurance Manager	Project Managers		

6.3 MISSION LEVEL DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
SMRD	PI & Co-PI's	NASA and CNES Program Managers	Project Managers	
SRD	Mission System Manager	Project Managers	Segment Managers	
Mission Validation Plan	Mission System Manager	Project Managers	Segment Managers	
Mission Test Report	Mission system Manager	Project Managers	Segment Managers	
MOCD	Mission Ops Manager	PI, Project Managers	Segment Managers	
Mission Specification	Boeing	KSC	Segment Managers	
Mission I, T, & V Plan	Mission AIT Manager	Project Managers	Segment Managers	

6.4 LAUNCHER INTERFACE DOCUMENTS

The documentation is defined in the CALIPSO Document List (and in Delta 2 planner's guide). The satellite related documentation is prepared by CNES, distributed as draft by CNES to NASA LaRC, NASA KSC, Boeing, Alcatel. The documentation is officially released by NASA LaRC.

6.5 SATELLITE DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Satellite Specification	Satellite Manager(CNES)	Mission System Manager (NASA)	Payload(NASA/ Ball) & Platform(CNES/ Alcatel) managers	Project Managers
Satellite Qualification Plan	Satellite Manager(CNES)	Mission System Manager (NASA)	Payload(NASA/Ball) & Platform(CNES/Alcatel) Managers	Project Managers

Satellite Test Report	Satellite Manager(CNES)	Mission System Manager (NASA)	Payload(NASA/ Ball) & Platform(CNES/ Alcatel) Managers	
PDIS (PL/PF Interface Specification)	PL/PF Interface Manager(CNES)	Satellite Manager (CNES)	Payload(NASA/ Ball) & Platform(CNES/ Alcatel) Managers	Project Managers
Payload Qualification Plan	Payload Manager	Payload Interface Manager (CNES)	Instruments Managers	Project Managers
Payload Test Report	Payload Manager	Payload Interface Manager (CNES)		
IIR Specification	IIR Manager	Payload Manager		CNES Science System Data Manager
IIR Qualification Plan	IIR Manager	Payload Manager		CNES Science System Data Manager
IIR Tests Report	IIR Manager	Payload Manager		

6.6 SATELLITE-GROUND SEGMENT INTERFACE DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Ground to Board Interface Specification	CNES	CNES	Platform Manager Payload Manager SOGS Manager MOGS Manager	Project Managers
Ground to Board Interface	CNES	CNES		

Validation Plan				
Ground to Board Interface Test Report	CNES	CNES		
Payload/MOGS Interface Specification	NASA	NASA		
Payload/MOGS Interface Validation Plan	NASA	NASA		
Payload/MOGS Interface Test Report	NASA	NASA		

6.7 GROUND SEGMENT DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Ground Segment Specification	GS Manager (NASA)	Mission System Manager (NASA)	MOGS Manager(NASA) and Satellite& SOGS System Manager (CNES)	Project Managers
Ground Segment I&T Plan	GS Manager (NASA)	Mission System Manager (NASA)	MOGS Manager(NASA) and Satellite& SOGS System Manager (CNES)	Project Managers
Ground Segment Test Report	GS Manager (NASA)	Mission System Manager (NASA)	MOGS Manager(NASA) and Satellite& SOGS System Manager (CNES)	
SOGS Specification	SOGS Manager (CNES)	Ground Segment Manager (NASA)		Satellite& SOGS System Manager (CNES)

SOGS Validation Plan	SOGS Manager (CNES)	Ground Segment Manager (NASA)		Satellite& SOGS System Manager (CNES)
SOGS Test Report	SOGS Manager (CNES)	Ground Segment Manager (NASA)		Satellite& SOGS System Manager (CNES)
MOGS Specification	MOGS Manager (NASA)	GS Manager (NASA)		
MOGS Validation Plan	MOGS Manager (NASA)	GS Manager (NASA)		
MOGS Test Report	MOGS Manager (NASA)	GS Manager (NASA)		

6.8 SCIENCE SEGMENT DOCUMENTS

Title	Prepared by	Approved by	Concurred by	Released by
Science Validation Plan	Science Validation Coordinator	PI & Co-PIs	Science Segment Manager	

6.9 DOCUMENTATION NUMBERING

The following convention will be used for mission documentation:

An eight-digit identifer in the following format (PC-aaa-yxx):

PC = the first and second letters designate the CALIPSO mission.

Aaa = the third, fourth, and fifth letters represent the functional area the document supports according to the following list:

SYS – System Level Document (e.g. SMRD)

SAT – Satellite Document

PLD – Payload Document

PFM –Platform Document

LVH – Launch Vehicle Document

GND –Ground Document

SCI – Science Document

OPS – Operations Document

AGR – Partner Agreement

PRJ – Project Management Document

Y = the sixth number shall designates a document type according to the following list:

1 - Specification

2 - Description Document

3 - Test Document

4 - Operations Document

5 - Programmatic

6 - Reserved

7 - Reserved

8 - Miscellaneous

9 - ICD

XX = Sequential Number of the document

For documentation within Segments or Systems of implementing organizations, the organization's document numbering convention will be used.

6.10 INTERFACE CONTROL

Interfaces are fundamental areas of concern with the CALIPSO project. All interfaces between mission products (segments or systems) are defined in Interface Control Documents (ICDs). The ICDs will be placed under configuration control after they have been developed by the appropriate project personnel and approved by the project management team. Changes to an ICD will use the configuration change control process outlined in the section 8, and detailed in the Configuration Management Plan (PC-PRJ-509).

7 *ALLOCATION MANAGEMENT*

The allocations are defined by common agreement of CNES and NASA in the SRD. Management of the allocations follows the guidance set forth in the tables below with control responsibilities defined as:

Approval — Approval Organization. The controlling organization shall not implement until approval is granted by the appropriate configuration control board (see section 8).

Control — Responsible for generating, maintaining, and distributing budget. Responsible for systems engineering, and performing trade studies.

Information — Information only. No action required.

Concur — Accepts the allocation as applicable

7.1 PERFORMANCE ALLOCATIONS

Lidar Footprint Control/Knowledge	**LaRC**	**CNES**	**LaRC via Ball**
Satellite Requirement	Control	Information	Information
Platform Allocation	Approval	Control	Information
Payload Allocation	Control	Information	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

On-orbit Altitude Knowledge	**LaRC**	**CNES**	**LaRC via Ball**
Satellite Requirement	Control	Information	Information
Platform Allocation	Approval	Control	Information
Payload Allocation	Control	Information	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information		Control

Altitude Knowledge (Post-Processed)	**LaRC**	**CNES**	**LaRC via Ball**
Satellite Requirement	Control	Information	Information
Platform Allocation	Approval	Control	Information

Payload Allocation	Control	Information	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information		Control

7.2 RESOURCES ALLOCATIONS

Mass	**LaRC**	**CNES**	**LaRC (via Ball)**
Launcher Satellite Requirement	Control	Information	Information
Satellite Allocations - Platform - Payload - Launch Vehicle Adapter - Satellite Margin	Concur	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Approval	Information	Control

Power	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	Information
Satellite Allocations - Platform - Payload - Satellite Margin	Concur	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

Volume	**LaRC**	**CNES**	**LaRC (via Ball)**
Launcher Satellite Requirement	Control	Information	Information

Platform Allocation	Concur	Control	Information
Payload Allocation	Concur	Control	Information
Platform Sub-Allocation	Information	Control	Information
Payload Sub-Allocation	Information	Information	Control

S-Band Data Rate	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	
Platform Allocation	Information	Control	
Payload Allocation	Information	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

S-Band Data Volume	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	
Platform Allocation	Information	Control	
Payload Allocation	Information	Control	Information
Platform Sub-Allocation	Information	Control	
Payload Sub-Allocation	Information	Information	Control

X-Band Data Rate	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Information		Control
Platform Allocation			
Payload Allocation	Information		Control
Platform Sub-Allocation			
Payload Sub-Allocation	Information		Control

X-Band Data Volume	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Information		Control

Platform Allocation			
Payload Allocation	Information		Control
Platform Sub-Allocation			
Payload Sub-Allocation	Information		Control

Delta-V Budget	**LaRC**	**CNES**	**LaRC (via Ball)**
Satellite Requirement	Concur	Control	
Platform Allocation	Information	Control	

Platform (including PLTM..) Mass memory Budget: same responsibilities as S-Band

P/L Mass memory Budget: same responsibilities as X-Band

8 *CONFIGURATION MANAGEMENT*

The applicable document for configuration control is The Configuration Management Plan PC-PRJ-509/AD07

8.1 DEFINITION

Configuration management is the systematic process for establishing and maintaining control of all CALIPSO baseline documentation, hardware, and software deliverables (configured items). It ensures that all proposed and actual technical and programmatic changes to CALIPSO configured items shall be systematically evaluated for validity, merit, need, and impact throughout the life cycle of the mission. It ensures that all affected organizations will be cognizant of the impact of such changes (i.e., performance, schedule, and cost) and will have participation in the decision process within an optimum time frame.

The section 8 of the NASA/CNES project plan is applicable to the CALIPSO Configuration Management Plan (PC-PRJ-509) which describes this discipline for the mission in more detail: the CALIPSO Configuration Management Organization, configuration identification, change control, definitions, procedures, and forms.

8.2 GOALS

Goals of configuration management are:

- to know, at all times, the technical description of the system and its components by means of approved documentation
- to control the changes to the technical description of the system
- to facilitate coherence between segment, system, and subsystem items (control of external interfaces), and the products within these entities (control of internal interfaces)
- to check that the documentation is and remains an exact reflection of the products that it describes
- to identify the applicable configuration and the applied configuration in order to deal with deviations and/or waivers detected during the production, delivery or use of the product
- to enable all users to know the possibilities and utilization limits of each example of the product and, in case of anomalies, the examples affected.

8.3 CONFIGURATION MANAGEMENT TASKS

The four main configuration management tasks are.

a. **Configuration Identification**: the technical documentation (plans, specifications, procedures, processes, etc.) and drawings (and their numbering convention) that identify and describe the approved configuration of a product during the project phases.

b. **Configuration Control**: the systematic evaluation, coordination, disposition, and implementation of proposed changes to a configured item. Deviations and waivers are formal changes and included in the configuration control process

c. **Configuration accounting and monitoring**: the recording and reporting of information required for the complete identification of the configuration; the description of all deviations on a product, between the configuration accepted at a given time and the applied configuration of the product.

d. **Configuration verification**: periodic surveys of design, fabrication, assembly, integration, and testing phases to verify that the configuration is identifiable and that changes are traceable to an established baseline and the design drawings and hardware are in conformance.

8.4 CONFIGURATION MANAGEMENT ORGANIZATION

Configuration control will be accomplished through configuration control boards set up according to the following hierarchy and responsibilities:

Configuration Management Hierarchy

Level	Controlled By	Responsible for	CCB Chair	CCB Membership	Sample Types of Baselined Documents
0	NASA Admin Code AE	PCA content	Administrator's Approval Only		- Program Commitment Agreement (PCA) Content
1	GSFC ESSP Project Off.	Science & Mission Level 1 Requirements	Mission Office -- Chairperson defined by Hqtrs (Change recommendations from PI, Dr. Dave Winker)	Determined by Chairperson	- Level I Requirements Document - Science and Mission Requirements Document Sections 2, 3, 4a (Level 1 Requirements) - NASA/CNES Memorandum of Understanding (MOU)
2	P-C PI	Science & Mission Integrity; Mission Level Functions (Cost, schedule, and performance control)	Mission Lead – Chairperson Dr. Dave Winker	- Co-PIs - Project Mgr - Deputy Proj Mgrs - Others as Required	- Descope Plan - ATBDs - SMRD level 2 requirements
3	P-C PM	Ensuring all Mission Segments Work Together to Satisfy Mission Requirements	Project Office -- Chairperson John Rogers	- PI - Deputy Proj Mgrs - System Eng - Mission Assur Mgr - Segment Leads - Others as	- Mission Implementation Plan - SRD (SMRD Sections 4b, 5, 6) - ICDs that describe/contain external interface requirements between Segments - Project Plan

				Required	
4	Segment Leads	Ensuring all Systems within Segments work together to satisfy Mission Requirements	Segment Lead - Individual CCB's	-System Leads - Mission Assur Mgr - Interface Managers - Mission System Engineer	- Segment Specifications - ICDs that describe interfaces between Systems within Segment
5	System Proj Mgrs	Completing Mission Systems	System Developers -- Individual CCBs	Determined by Organization but should include members from affected systems	- Systems Specifications (including drawings) - Internal Interfaces - Data Requirements Descriptions
6	Managing Organizations	Subcontractor Elements	Subcontractors CM Requirements set by customer contract Subcontractor implements CM according to individual company processes and contractual requirements and agreements		- Data Requirements Descriptions

The following Interfaces between systems in different segments will be handled as such: P/F//SOGS→Satellite Segmen P/L//MOGS→Ground Segment. Unresolved change requests at level 4 will be submitted to the CALIPSO Project management fc direction. If the CALIPSO Project Management is unable to resolve the differences it will be submitted to the JSG for direction.

The NASA and CNES CALIPSO Mission Configuration Managers (C Mgr) , for the items under the responsibility of their respective agency, are responsible for:

- Identifying and monitoring the baseline configuration

- Delivering the applicable documents

- Implementing the change process-- initiating instructions, receiving Change Proposals, organizing CCBs, validating changes and archiving change files

- Recording and producing the configuration statuses

- Freezing the configuration baselines during reviews and at milestones.

8.5 CONFIGURABLE ITEMS

8.5.1 Documents

Documents that have been identified as NASA/CNES Configurable Items are indicated in the Document List (PC-SYS-804).

8.5.2 Hardware/Software Deliverables

Hardware and Software that have been identified as NASA/CNES Configurable Items are indicated in the Deliverables Item List (PC-SYS-801)

8.6 CONFIGURATION BASELINES

The configuration management principles are based on establishing and validating baselines from which all changes are formalized and checked. A Configuration Baseline is characterized by a set of documents describing the characteristics of a product. These are the Configuration Baselines for the CALIPSO Mission.

- **Allocation/Requirements Configuration** frozen at end of pre-phase B (SRR). This configuration is baselined by the release of the Science and Mission Requirements Document.

- **Development Configuration** frozen at end of phase B (PDR). The documents identifying this configuration are the Partnering agreements, the SRD (Segments Requirement Document) the, Segment/System Specifications, and Interface Control Documents (preliminary).

- **Production Configuration** frozen at end of phase C (CDR). The documents identifying this configuration are approved engineering designs with final documentation, Integration & test plans/procedures and final Interface Control Documents. At end of phase C, a document will identify the documentation of this configuration.

9 *SCHEDULES AND DEVELOPMENT LOGIC*

9.1 SCHEDULES

There are three levels of schedules that are described in the following sections. The lowest level of schedule (Level III) contains detailed development logic. The next higher level of schedule (Level II) contains a synthesis of the detailed Level III schedules and focuses on key milestones and deliveries between organizations. The highest level of schedule, the Level I or Master Schedule, is a one-page summary of the Project Schedule.

9.1.1 Level I (Master) Schedule

The CALIPSO Mission will be implemented according to the configuration controlled master schedule. This schedule is maintained on Livelink and is accessible to the entire CALIPSO team. This schedule establishes the interrelationships and time phasing of activities and events essential for the timely and effective implementation of the program, and identifies critical paths. This one-page schedule is developed by NASA Langley Research Center using the Level II schedule as input.

9.1.2 Level II (Project) Schedule

The Level II schedule is based on a synthesis of each component schedule (Level III schedule) and delivered to LaRC. The level II schedule is focused on key milestones and deliverable dates. The schedule is configuration controlled and is maintained on Livelink. The schedule is accessible to all members of the project. Each organization is responsible for providing an input Microsoft Project file that NASA uses to generate the Level II schedule. NASA is responsible for integrating the elements of the Level II schedule. The Project schedule is managed jointly by NASA and CNES.

9.1.3 Level III (Detailed) Schedules

The Level III schedule is developed by the organization responsible for the product. This schedule is used internally by that organization and is not provided to the Project (NASA). The Level III schedules contain the detailed development logic, durations, and critical paths of the component items and are closely managed. The Level II schedule is developed from this detailed schedule.

9.1.4 Schedule Maintenance

The Level I and II schedules are maintained under configuration control by the Project Office. These schedules will be statused on a weekly or monthly basis as required. Milestones in danger of slipping will be immediately assessed for impact to mission partners.

10 *MISSION REVIEWS*

10.1 MISSION REVIEWS: PURPOSE AND CONVENING AUTHORITIES

Meetings and reviews required to carry out the responsibilities set forth in the MOU will be held periodically in the United States, France and at other sites as mutually agreed.

Mission level reviews will be conducted on approximately one-year intervals to ensure satisfactory progress in meeting mission requirements. These reviews will be conducted in accordance with the Integrated Independent Review Plan.

The purposes of the reviews are to provide an independent assessment of the continuing ability of the Mission to meet its technical and programmatic commitments and to provide value-added assistance to the Project Managers as required.

Major project reviews are conducted according to the following mission architectures.

a) Mission (Segments: launch, satellite, ground, science);

b) System (Platform, payload….)

c) Subsystem (Instruments..).

For the MCR and MRR, the reviews will be chaired by the GPMC and CNES will be a voting member. Both Parties will furnish engineering and programmatic data and will participate in these mission reviews, as mutually agreed.

TABLE 10-1:MISSION LEVEL REVIEWS

Review	***Appr Dur***
MCRR	2-3 hrs
MRR	2-4 hrs
MDR	2 days
PSR	1 day
CDR	2 days
PSRR	2 days
FRR	½ day

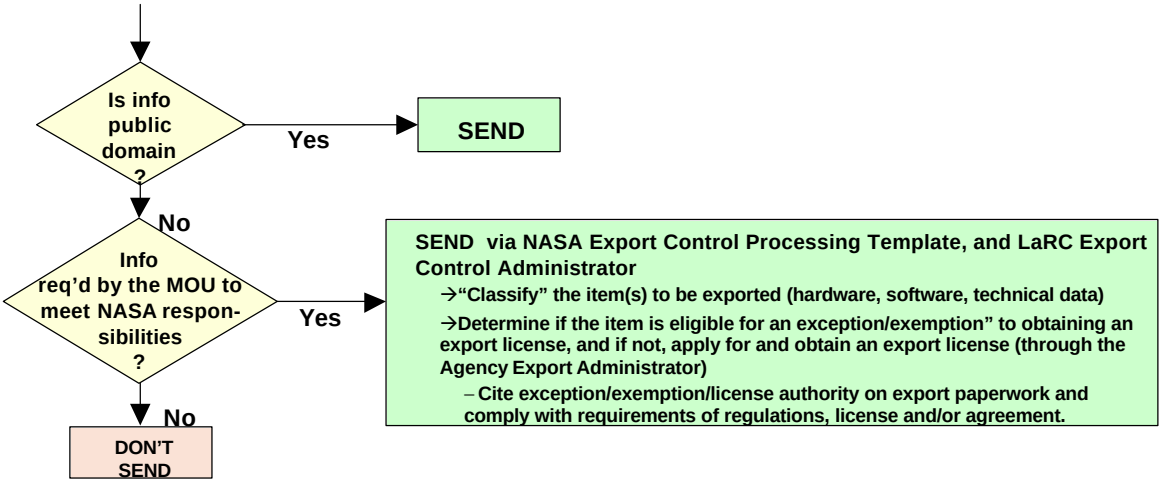
10.2 MISSION REVIEW BOARD

LaRC and CNES will strive to help maintain consistent chairperson(s) and committee members for all reviews.

11 *DATA AND INFORMATION POLICY*

Data and information will be exchanged in accordance with the MOU, national laws and regulations, Technology Transfer Control Plan (PC-PRJ-514), and industry regulations. The process used to export data and information is described in Figure 11-1.

Figure 11-1: ITAR EXPORT PROCESS



11.1 REVIEWS

The Payload Design Reviews are segmented as follows:

- Segment 1: Open to full international participation; will meet NASA's responsibilities--interface, integration, safety, mission development, test plans; consistent with the NASA/CNES MOU

- Segment 2: Tabletops restricted to U.S. participation; review of detailed design, development, production, and manufacture data

11.2 SCIENCE DATA POLICY

According to the NASA/CNES MOU, access to science data will be as follows:

1. In all cases, the Parties will provide immediate access to all CALIPSO payload science data and science data products, free of charge, for members of the science team, as well as designated representatives of science team members, including associates, staff and co-workers. The Parties will also provide free of charge, payload science data and science data products necessary to the scientists selected for validation.
2. Science data products will be made available to the public and the science community by NASA in a Hierarchical Data Format (HDF)-standard data format after

the appropriate science calibration and validation, at no more than the cost of fulfilling the user request. In order to promote rapid access to science data products, some preliminary science data products will be archived after initial verification, but prior to full validation, and made available to all users at no more than the cost of fulfilling the user request.

3. All X-band satellite telemetry, payload science data and science data products obtained from the CALIPSO mission will be archived in appropriate NASA data centers as defined in the CALIPSO Project Plan. Copies of the CALIPSO science data products will be exchanged between the Parties.
4. The CALIPSO science team members (including designated representatives) and scientists selected for validation must provide a report to the Parties on the results of their analysis and validation investigations.
5. All users, including the CALIPSO science team members and scientists selected for validation, should provide a report to the Parties on the results of their investigations on validated CALIPSO science data.
6. Notwithstanding any termination of this MOU by either Party, any X-band satellite telemetry and science data products obtained from the CALIPSO mission, as defined in the CALIPSO Project Plan, shall be archived by NASA for at least 10 years after completion of the CALIPSO mission, unless otherwise agreed by the Parties.
7. The analyzed results obtained from the CALIPSO mission will be made available to the general scientific community through publication in appropriate journals or presentations at scientific conferences as soon as possible and consistent with good scientific practices. In the event that such reports or publications are copyrighted, the Parties shall have a royalty free right under the copyright to reproduce, distribute and use such copyrighted work for their own purposes.

12 *PROJECT MANAGEMENT PROCESSES*

12.1 PROJECT REPORTING

A Monthly Report is prepared by LaRC for NASA and CNES management which includes the following Information;

- Project Status (Fever Chart)
- Past Month Accomplishments in System Engineering, Instrumentation, Satellite, Launch Services, Science Data System and Mission Operations System
- Planned Activities for Next Month in Each Area Listed Above
- Top Ten Concerns, Complete with History of Each
- Resource Margin Status
- Facility Utilization Status
- Risk Management Report
- Schedule Reserve Status
- Update of the Master Schedule

CNES will provide information to LaRC for its responsibilities on a monthly basis, and LaRC will provide the project report to CNES for information.

12.2 COMMUNICATIONS

Effective communications is vital to the mission success. The following methods will be utilized to ensure appropriate and timely interchange.

- Technical Representatives from CNES, LaRC on-site at each other's facilities
- Telecons (weekly, monthly, as needed)
- Monitoring/Reporting (weekly, monthly, as needed)
- Focused Technical Interface Meetings (face-to-face) with partners on a regular basis and in combination with other reviews when possible
- Reviews
- E-mail
- Documentation: Formal & Informal
- Livelink server for various functions:
    - Document Library
    - Project Status

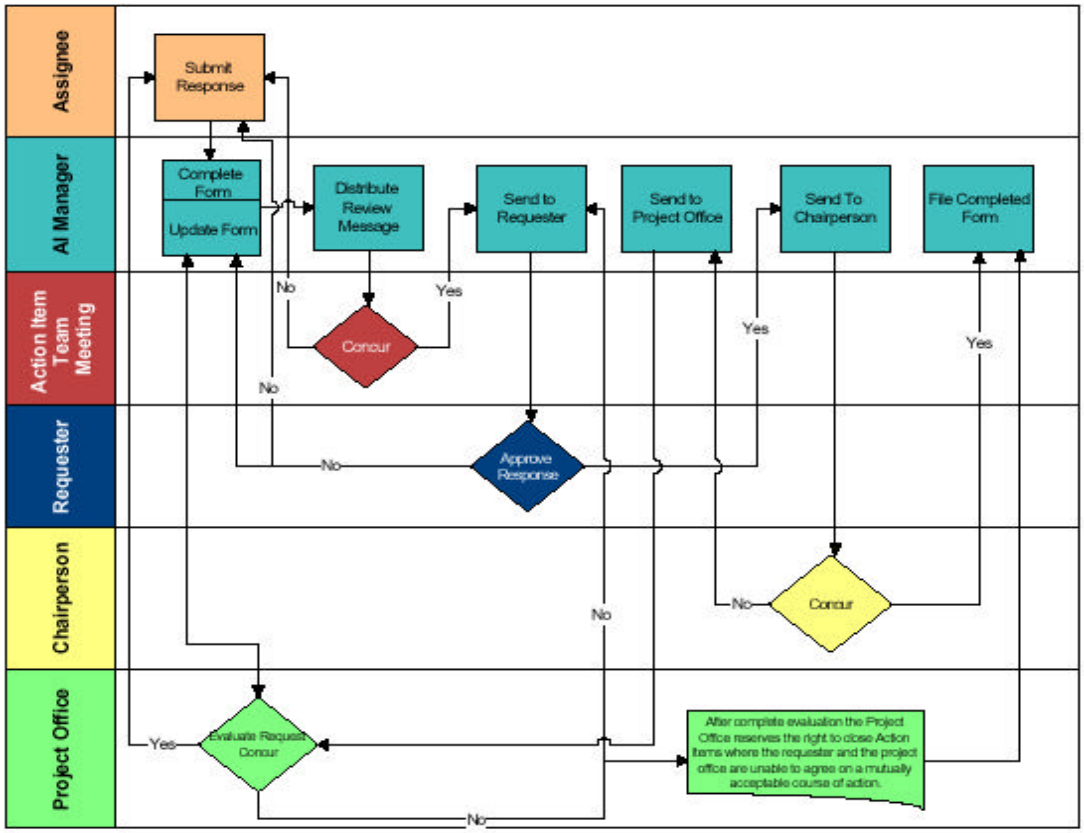
- News
- User's Subprojects
- Threaded Discussions

- Project Calendars
- Videocon Network Established

12.3 ACTION ITEM MANAGEMENT

The Action Item Closure process is defined in Figure 12-1. To summarize, each action item is assigned a unique number, an individual who is responsible for drafting the project's response, and a due date. The Information Manager tracks each action item to ensure timely response and closure. Once the response to the action is completed, the core CALIPSO management team meets to discuss the response and approve it prior to submittal to the requester for closure.

Figure 12-1 Action Item Closure Process



12.4 MISSION ASSURANCE

The Mission Assurance Management Plan (MAMP) (PC-PRJ-503) describes the mission assurance activities to be performed by NASA and CNES to ensure that the mission assurance objectives are met for the CALIPSO Project.

The CALIPSO project is organized into four segments: Ground, Launch, Satellite, and Science. Mission Assurance applies to all four segments. NASA, LaRC will exercise oversight of all segments' assurance planning and activity in concert with CNES' assurance representatives. The MAM is also responsible for Mission level Configuration Management (CM) and Risk Management in accordance with the separate CM and Risk Management Plans.

The MAM will ensure mission assurance activity within the following six functions: Quality Assurance, Failure Reporting, System Safety Management, Mission Reviews, Design Assurance, and Software Quality Assurance. Quality Assurance will include evaluation of transportation planning and operations.

12.5 SAFETY

Each mission system provider will generate their own Safety Plans that satisfy their unique internal requirements. An overall Safety Plan (PC-PRJ-505) will be generated by NASA and a Satellite Safety Plan will be generated by CNES to address all integration aspects as well as the types of safety features and mission level safety requirements that are levied upon all mission partners.

12.6 ENVIRONMENTAL IMPACT

Environmental Impact for the CALIPSO mission will address the environmental assessment performed in conjunction with the launch vehicle as well as the environmental assessment that is required due to putting a laser in space. The Environmental Impact Statement will address all aspects of using the instruments in space.

12.7 RISK MANAGEMENT

The CALIPSO Continuous Risk Management (CRM) Plan (PC-PRJ-504) defines the process and implementation of conducting CRM throughout the life-cycle of the CALIPSO mission. This document states that NASA and CNES will manage their risks in accordance with their respective procedures. Implementing CRM for the mission will provide a continual risk process (identify, analyze, plan, track, and control) for all disciplines and phases ensuring that communications and documentation are maintained across the entire mission and that informed decisions can be made on a timely basis. This CRM Plan is intended to complement overall CALIPSO Mission

Management and therefore CRM will be an integral part of project management. The implementation of this plan solicits inputs from everyone across the entire mission.

All project personnel are responsible for identifying, analyzing risks, planning mitigation strategies, and communication of the risk and its resolution. The project mission assurance personnel will perform the risk tracking and control functions.

12.8 SOFTWARE QUALITY ASSURANCE

The CALIPSO Software Quality Assurance Plan (PC-PRJ-513) establishes/defines the policies, standards, procedures, and practices for software assurance of all computer software for applications developed for the CALIPSO project. Software Quality Assurance applies to all software activities for the ground, launch, satellite, and science segments.

APPENDIX 1: FACILITIES AND LOGISTICS FACILITIES

In order for CNES and NASA to execute this Project, certain facilities, buildings, test complexes, ground stations, etc., are implicit and necessary to meeting the respective responsibilities. These facilities must be provided by each agency in accordance with the MOU. The lists of facilities provided below includes those owned directly by CNES, NASA, and/or its contractors and support agents that are available and are expected to be used for their intended purpose during the conduct of this Project.

For NASA, the facilities to be provided under the authority of the Project for the execution of CALIPSO are listed as:

Facilities	Activity	Agent	Location
Building/Offices	*Project Office*	NASA	Hampton, VA
Building/Laboratories			
Manufacturing	*Launch Vehicle*		
Complex	*Development*		
Launch Complex	*Satellite Launch*		
Tracking Station			

For CNES, the facilities to be provided under the authority of the Project for the execution of CALIPSO are listed as:

Building/Offices	Project Office	CNES	Toulouse
Building/Offices	Satellite Operations and Control	CNES	Toulouse
Building/Offices	Satellite contractor	ALCATEL	Cannes
Test facilities	Satellite contractor	ALCATEL	Cannes
Building/Offices	ISM contractor	SODERN	Limeil-Brevannes
Test facilities	ISM contractor	SODERN	Limeil-Brevannes
Tracking Station	Satellite Tracking	CNES	TBD

LOGISTICS

Regular telecons will be organized to facilitate direct contact between the various parties involved in the project.

APPENDIX 2: ACRONYMS

ABS	A-band spectrometer
AIT	assembly, integration, and test
ATBD	Algorithm Theoretical Basis Document
BOL	beginning of life
CDR	Critical Design Review
CNES	Centre National d'Etudes Spatiales
Co-PI	Co-Principal Investigator
COTS	commercial off the shelf
DAAC	Distributed Active Archive Center
DAO	Data Assimilation Office
DCN	Data Communication Network
DHU	data handling unit
DPM	Deputy Project Manager
EEE	electrical, electronic, and electromechanical
EEPROM	electrically erasable programmable read only memory
EMC	electromagnetic compatibility
EMI	electromagnetic interference
EOL	end of life
EOS	Earth Observing System
EOS AM	Earth Observing System Anti Meridian
EOS PM	Earth Observing System Post Meridian
EOSDIS	Earth Observing System Data and Information System
ESSP	Earth System Science Pathfinder
FMEA	failure mode and effects analysis
FOV	field of view
FRR	Flight Readiness Review
FTP	file transfer protocol
GDIS	General Design and Interface Specification
GDS	ground and data systems
GPS	global positioning system
GSE	ground support equipment
GSFC	Goddard Space Flight Center
HDF	hierarchical data format
HU	Hampton University
I&T	integration and test
IASI	Infrared Atmospheric Sounding Interferometer
ICC	instrument control computer
ICD	interface control document
ICU	instrument control unit
IDL	interactive data language

IEEE	Institute of Electrical and Electronic Engineers
IFOV	instrument field of view
IIR	imaging infrared radiometer
IP	internet protocol
IPCC	Intergovernmental Panel on Climate Change
IPSL	Institut Pierre Simon Laplace
ISAP	International Science Advisory Panel
ISM	Infrared Sensor Module
LaRC	Langley Research Center
LITE	Lidar In-space Technology Experiment
LRR	Launch Readiness Review
M&P	materials and processes
MAM	Mission Assurance Manager
MCR	Mission Confirmation Review
MDRA	mission definition and requirements agreement
MOCC	Mission Operations Control Center
MOGS	Mission Operations Ground System
MODIS	Moderate-Resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
MRR	Mission Readiness Review
NEPA	National Environmental Protection Agency
NFR	Nonconformance/Failures Report
NRC	National Research Council
OMA	Office of Mission Assurance
PDDS	Payload Data Delivery System
PDR	Preliminary Design Review
PGGS	PROTEUS Generic Ground Segment
PI	Principal Investigator
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
P/L	payload
PM	Project Manager
POCC	Payload Operations Control Center
POLDER	Polarization and directionality of the Earth’s reflectance
PPRR	Payload PreShip Readiness Review
PROTEUS	Plateforme Reconfigurable pour l’Observation, les Telecommunications, et les Usages Scientifiques
SPRR	Satellite PreShip Readiness Review
SE	systems engineer
SER	systems engineering report
SOCC	satellite operations control center

SOGS	Satellite Operations Ground System
SRR	Systems requirements review
SSR	solid state recorder
STA	star tracker assembly
TBD	to be determined
TBR	to be reviewed
TOPEX/Poseidon	ocean topography experiment
TRR	Test Readiness Review
TTCET	Telemetry and Telecommand Earth Terminal
WBS	work breakdown structure
WFC	wide field camera

APPENDIX 3: MISSION INTEGRATED TEAM ORGANISATION

The main objective of the participation of CNES people on the team is to provide insight into the end-to-end system and have, at a single place, the capability to solve all the technical and programmatic problems related to the mission, by:

- Improving communications: provide same understanding of issues and solutions to NASA and CNES. The same access to information and tools is necessary to reach common understanding of the problems and for day-to-day work.
- Providing the capability to coordinate mission levels studies and planning (e.g. mission analysis and mission AIT) with the relevant people on both sides at the same location.
- Provide status of development (e.g. schedule, risk, issues, etc.)

1 MISSION INTEGRATED TEAM ORGANIZATION

The proposed mission integrated team is organized around the hierarchy of the product tree.

1.1 Mission Coordination

The mission level coordination is shown in Figure 1.

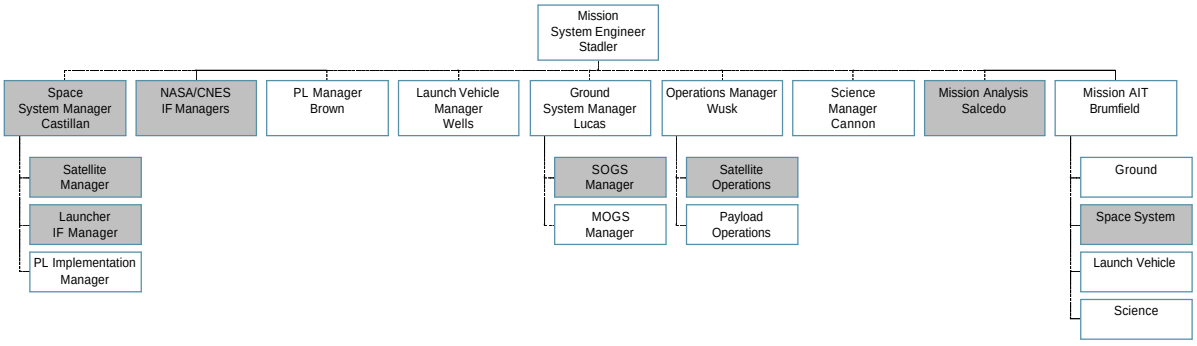


Figure 1 Mission level coordination, the Mission SE is responsible for coordinating mission level activities.

Comments:

- The mission integrated team consists of the segment leads, PL manager, NASA/CNES IF manager, and the Mission Systems engineering team.
- The Space System Manager leads the CNES participation to the Mission Integrated Team.
- The mission systems engineer is responsible for coordinating mission level activities (e.g. segment interfaces, mission design, mission AIT&V).

- The mission systems engineer (NASA) coordinates with the segment managers for all the mission level allocations, agreements, decisions ; he relies on the NASA and CNES Mission team members when needed.
- The mission systems engineer, as responsible of the development of the mission, is responsible of all the mission level studies, including when they involve the NASA or CNES Mission team members.
- Mission analysis (e.g. formation flying requirements, mission design, constellation coordination) activities:
    - LaRC is in charge of coordination with the other projects of the Afternoon Constellation.
    - CNES is in charge of the Calipso Mission Analysis
- Mission AIT is coordinated by LaRC.
- The NASA/CNES IF managers coordinate with the Satellite, Ground and Operations teams (i.e. facilitates the interactions between NASA and CNES team members) as described in the satellite integrated team proposal. The IF managers arrange meetings/telecons as necessary and help to ensure that communication between the US and French team members is clear. The NASA/CNES IF managers are located at Langley part time (7-10 days/month), and part time at CNES.

1.2 The NASA Mission team members include:

- Mission design
- Segment interfaces
- Mission AIT/AIV
- Performances (related to mission)
- Ground system lead
- Operations lead
- Science lead
- Launch vehicle lead

1.3 The CNES Mission team members include:

- Satellite lead
- Mission analysis

- Performances
- AIT/AIV
- Ground system
- Operations
- LV Interfaces

1.4 CNES Participation Summary

The NASA/CNES IFManagers work part-time at NASA Langley Research Center, part time at CNES.

CNES Mission Analysis occasionally works at NASA Langley Research Center.

CNES AIT manager occasionally works at NASA Langley Research Center.

Quarterly mission level TIMs

APPENDIX 4: SATELLITE INTEGRATED TEAM ORGANIZATION

CALIPSO SATELLITE INTEGRATED TEAM ORGANISATION AT TOULOUSE

The main objective of the participation of NASA/Ball people to the team is to have, at a single place, the capability to solve all the technical problems related to the satellite, particularly the implementation of the Payload on the satellite, by:

- Improving communications: same access to information and tools is necessary to reach common understanding of the problems; when people live together, they are obliged to solve disagreements in a timely manner, while when they are on both sides of the ocean, they can live a long time with diverging approaches, each side considering only its own approach as valid and applicable (e.g. mechanics!)
- Having at the same place the right people capable (alone or with the support of their respective teams) to reach decisions/agreements and make sure they are applied by their respective teams; by such, avoiding that the decisions/agreements of one day are denied the day after by some other project team members (clear assignment with delegation/responsibility)
- When needed, having at the same place the capability to perform satellite levels studies, with the relevant people on both sides, in the cases where Payload and Platform interact such that working at interface is not sufficient.

1 Integrated team Organisation

1.1 NASA CONTRIBUTION

The participation of NASA to the CNES team is:

1) A full time NASA engineer, appointed by NASA as "responsible of the implementation of the payload on the satellite" , with support of the NASA PL systems engineer at Ball:

- Responsible for PL interfaces, for PL budgets and satellite related performances, for NASA participation to satellite analyses -ex stability, Boresight mechanism design optimization-) ; responsible with respect to CNES for Payload qualification, procurement and AIT
- In NASA organization the PL implementation manager is in charge of these responsibilities, and has the capability to be supported directly, upon request, by LaRC and Ball engineers.

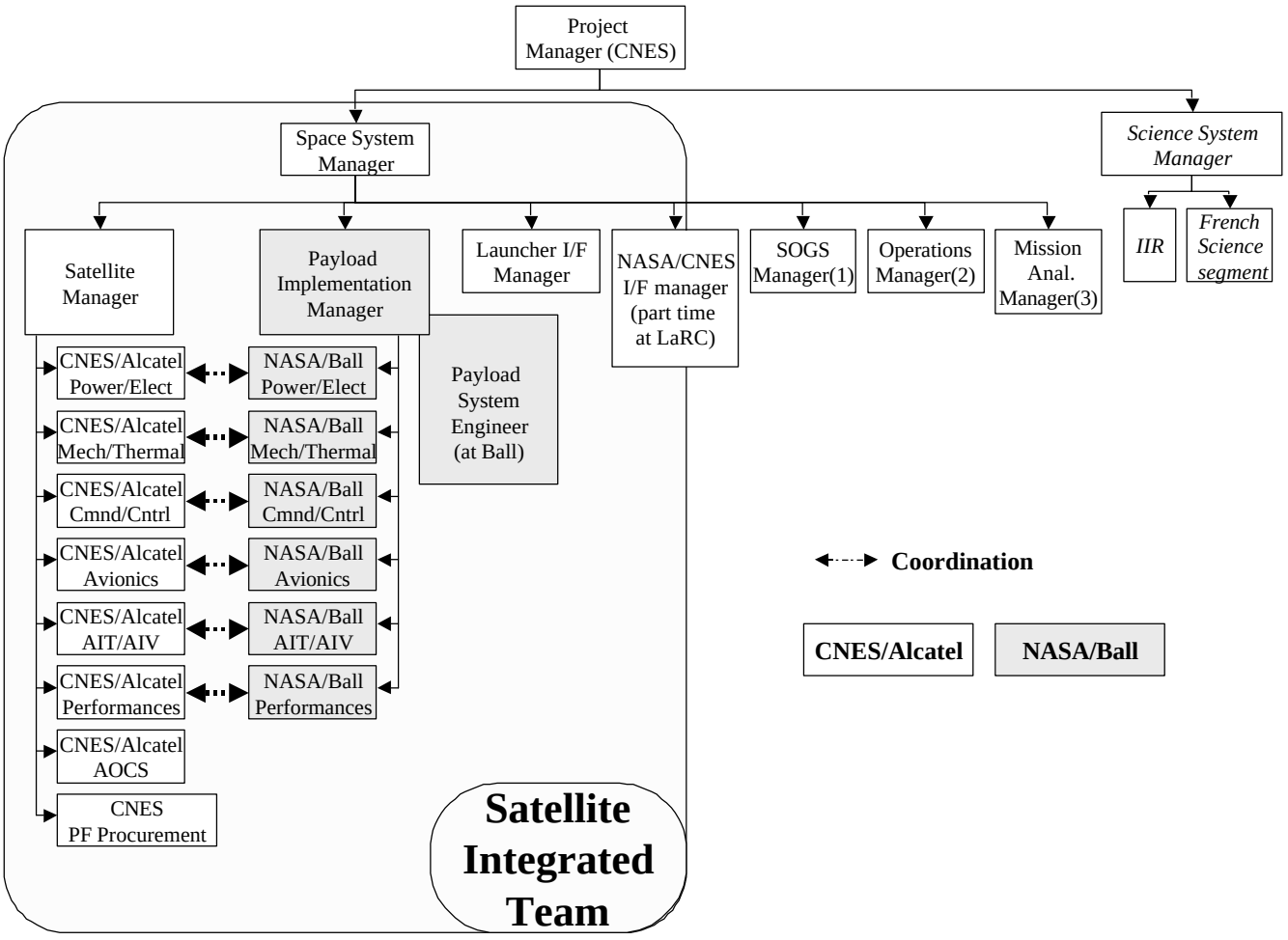
- He Coordinates with the space system lead in CNES and reports to NASA : PL implementation manager decisions/agreements commit NASA/Ball for his domain of responsibility (up to him to get right approvals).

2) Participation to common working sessions, with architects from both sides, quarterly and upon request.

3) A part time AIT engineer, starting approx. mid 02 for AIT/AIV preparation at Toulouse, then additional full time AIT engineer at Alcatel starting from Payload delivery (March 03).

1.2 SATELLITE INTEGRATED TEAM ORGANISATION

The Chart shows the SIT organization and its relationship with the CNES project organization



Comments:

- Space System manager (P.Castillan) is responsible in CNES for coordinating the work of the space System. Consequently, he is also responsible for coordinating the work of the Satellite Integrated Team ; he is, for NASA, the Satellite Segment Lead and, as such, is the interlocutor of NASA for satellite (and ground & operations)
- Payload Implementation Manager (A.Little) is full time in Toulouse; Payload AIT manager is part time in Toulouse till March 03 (start of sat AIT), then additional AIT engineer full time at Cannes ; NASA/Ball Architects are at Toulouse only during specific working sessions, quarterly and upon request.
- Payload Implementation Manager (NASA) reports to the Space System manager (Satellite Segment Lead) for all the allocations, agreements, decisions ; he relies on NASA/Ball architects when needed and the Space System manager relies on CNES/Alcatel architects when needed.
- The Satellite manager (J.Blouvac), as responsible of the development and the procurement of the satellite, is responsible of all the satellite level studies, including when they involve the NASA/Ball architects.
- NASA/CNES I/F manager (P.Ferrier) (CNES) is in charge of the PL/PF interface management (PDIS, PDP, deliveries, etc..) part time, and he resides part time (1 week/10 days per month) at LaRC for facilitating NASA/CNES communication on additional topics than satellite ones (SOGS, operations, System, IIR). He makes commitments for the Platform/Payload Interface related area.
- NASA Payload systems engineer (D.Rosenbaum)(at Ball) coordinates with the payload implementation manager for Ball support for payload development and interface issues.
- Launcher I/F manager is Joel Dejoie
- The CNES and Alcatel architects include, for platform and Satellite:
    - Power
    - AOCS
    - Mechanical & Thermal
    - Control-Command
    - Interfaces
    - AIT/AIV
    - Performances

- Platform procurement
- The NASA and Ball architects include, for Payload:
  - Power
  - Mechanical & Thermal
  - Payload / Platform interfaces
  - AIT/AIV
  - Performances (related to satellite, not instruments)

2 Phases/Schedule of implementation

The first phase of implementation is till the Mission CDR, in order to solve all the interfaces, ICD's & compatibility remaining issues, prepare and issue the ICD's.

The second phase is between Payload CDR/SMRR and payload delivery.

The third phase is the satellite AIT

The fourth phase is the launch campaign.

We will focus on the first short term phase.

2.1 TILL MISSION CDR

Objective: to solve all the interfaces, ICD's & compatibility remaining issues ; to issue the ICD's

2.2 FROM MISSION CDR TO PAYLOAD DELIVERY

The participation should be limited for the most part to the Payload Implementation Manager and the NASA PL systems engineer at Ball, with in addition some working sessions quarterly and when needed, and progressive involvement of the Payload AIT manager.

2.3 SATELLITE AIT

A payload integration team is approx full time at Cannes during Satellite AIT, under the leadership of the Payload AIT manager.

2.4 LAUNCH CAMPAIGN

A payload integration team and satellite integration team is approx full time at VAFB during LV AIT. The respective responsibilities are still to be discussed

CALIPSO SIT: Nomination of the technical responsibility

2.5 ROLES & ORGANIZATION:

- For each discipline (Mechanical & Thermal, Electrical, Command & Control, AIT, Satellite & Payload system), one CNES lead and a NASA co-lead are appointed.
  - Their area of responsibility includes and is limited to all the topics related to their discipline (applied to the satellite) as far as they don't interfere with "outside": in case they address issues that are beyond their area of responsibility (impacts on performances, on interfaces, on other disciplines, ...), or in case they don't reach solutions, or if they don't solve disagreements at their level, they are directed to report to the core team.
  - The lead is in charge to organize the actions relative to his discipline ; he commits for the satellite and the platform in the area of his discipline.
  - The co-lead coordinates with the lead for organization of work ; he commits for the payload in the area of his discipline.
  - The lead and co-lead, inside their field of responsibility:

    - are charged to organize the work, to reach decisions, to solve the problems.

    - they define the participants for studying the issues, they define the actions assignees, the meeting attendees.

    - they ask for necessary support in their respective organisations (NASA + BALL; CNES + ALCATEL).

    - they are directed to report the progress of their work and their decisions reached to the "core team" (see list hereafter).

    - they are directed to report to the core team in case of issues that are beyond their area of responsibility (impacts on performances, on interfaces, on other disciplines, ...), or in case they don't reach solutions, or if they don't solve disagreements at their level.
  - The CNES leads report to Patrick Castillan (relations with NASA, impacts on payload, mission level..) and to Jean Blouvac (relations with Alcatel, satellite engineering, impacts on platform,…)
  - The NASA co-leads report to Alan Little and to Kevin Brown (relations with Ball)

- For each discipline, the exchange of information (questions, data, etc...) between the two agencies are transmitted through the lead for CNES and the co-lead for NASA. The core team is in copy.

2.6 APOINTMENT:

- Mechanical & Thermal:

Lead	***Joel DEJOIE***	Phone number	***05.61.28.14.55***	Email address	***joel.dejoie@cnes.fr***
Co-lead	***Scott HILL***	Phone number	***757-864-7029***	Email address	***s.a.hill@larc.nasa.gov***

- Electrical :

Lead	***Pierre TASTET***	Phone number	***05.61.27.46.66***	Email address	***pierre.tastet@cnes.fr***
Co-lead	***Dave ROSENBAUM***	Phone number	***303-939-6603***	Email address	***d.m.rosenbaum@larc.nasa.gov***

- Command & control :

Lead	***Helene COTTET***	Phone number	***05.61.27.43.15***	Email address	***helene.cottet@cnes.fr***
Co-lead	***Mary-Beth WUSK***	Phone number	***757-864-3830***	Email address	***m.e.wusk@larc.nasa.gov***

- Avionics:

Lead	***Emmanuel Robert***	Phone number	***05.61.27.32.05***	Email address	***Emmanuel.robert@cnes.fr***
Co-lead	***Ron Verhappen***	Phone number	***757-864-2405***	Email address	***r.c.verhappen@larc.nasa.gov***

- Satellite & Payload system:

Lead	***Jean BLOUVAC***	Phone number	***05.61.28.27.82***	Email address	Jean.blouvac@cnes.fr
Co-lead	***Alan LITTLE***	Phone number	***757-864-1656*** ***05.61.27.33.09***	Email address	a.d.little@larc.nasa.gov ***alan.little@cnes.fr***

- Satellite A I T:

Lead	***Patrick Hozé***	Phone number		Email address	
Co-lead	***Larry BRUMFIELD***	Phone number	***757-864-3793***	Email address	***m.l.brumfield@larc.nasa.gov***

- Core team:

  - CNES: Patrick CASTILLAN, Jean BLOUVAC, Pierric FERRIER, Bruno BELON.

  - NASA: Kevin BROWN, Alan LITTLE, John STADLER, Mary Beth WUSK, Mike BLYTHE, Debbie DAJON, John ROGERS.

Table 1 Roles of SOGS, Satellite Ops and Mission Analysis Managers in the CNES Space System Team, and in the Mission Integrated team

	CNES Space System Team	Mission Integrated Team
SOGS Manager	Develop & assemble SOGS SOGS-Sat I/F	SOGS requirements vs Ground segment SOGS-MOGS I/F Participation to end to end tests
Satellite Operations Manager		
Mission Analysis Manager	Define strategy compliant with requirements Implement	Define formation Flying agreement with other missions → define Mission flying requirements

ANNEX C

NASA KSC / Analex Corporation

Expendable Launch Vehicle Integrated Services (ELVIS) Contract Statement of Work (SOW)

1.0 Safety

ANALEX shall perform systems safety assessments, procedure reviews, and operations surveillance of spacecraft contractor design, integration, and test activities to ensure the identification and assessment, and elimination, or control of hazards.

1.1 Systems Safety Assessments

ANALEX shall perform system safety assessment of mission unique design, integration, test activities, and launch preparations. ANALEX shall participate in the tailoring of applicable safety requirements. ANALEX shall review and provide assessment of Spacecraft and Expendable Launch Vehicle (ELV) Missile System Pre-launch Safety Packages (MSPSP) or equivalent documents, variance requests, and design changes.

1.2 Procedure Reviews

ANALEX shall review all integrated procedures classified as hazardous to ensure hazardous operations are identified and appropriate safety precautions are implemented. In both cases, ANALEX shall assess all non-hazardous procedures to ensure proper classification.

1.3 Safety Surveillance and Support of Operations

ANALEX shall perform safety surveillance and assessments of all hazardous operations for NASA and Non-NASA missions when processing takes place on NASA property or within a NASA facility. ANALEX shall perform safety surveillance of all NASA mission integration activities that are classified as hazardous and are being performed on Launch Service Provider (LSP) property or within a Launch Service Provider (LSP) facility.

1.4 Participation in Meetings, Reviews, and Working Groups

ANALEX shall participate in NASA, Launch Service Provider (LSP) and spacecraft contractor, meetings/reviews including, status meetings, Technical Interchange Meetings, Design Reviews, Phase Safety Reviews, Payload Safety Working Groups, and Ground Operation Working Groups for NASA missions and other processing operations in NASA's assigned facilities.

1.5 Safety Training

ANALEX shall develop and conduct safety training including all required facility access/safety training for all NASA customers, NASA transient/resident, and contractor personnel for each NASA mission.

1.6 Quality Surveillance of Launch Service Provider (LSP)

ANALEX shall provide surveillance at all manufacturing, processing, testing, and launch site locations. ANALEX shall participate in local reviews, meetings, pertinent tests and local site visits.

1.7 Design Reviews:

ANALEX shall participate in Preliminary Design Reviews (PDR), Critical Design Reviews (CDR), and Design Certification Reviews (DCR), Mission Unique Requirements Reviews (MURR), Mission Unique Preliminary Design Reviews (MUPDR), and Mission Unique Critical Design Reviews (MUCDR). ANALEX shall review and provide technical assessment of Design restrictions, limitations and known violations including system safety, hardware and software.

1.8 Production Reviews

ANALEX shall participate in Hardware Acceptance Reviews (HAR), Pedigree Reviews, Production Reviews, and Pre-Vehicle-On-Stand Reviews (Pre-VOS). ANALEX shall review and provide technical assessments on any build paper, test results, non-conformance reports, discrepancy history, failure analysis, waivers, deviations, and MRB's presented at reviews.

1.9 NASA Launch Readiness Reviews

ANALEX shall attend Pre-Launch Readiness reviews (LRR and FRR) and launch activities.

2.0 Launch Site Support Engineering

ANALEX shall work with the NASA Launch Site Integration Manager (LSIM) for all ground processing mission activities and provide launch site support documentation, launch site operational services, launch operations management support, and launch site administrative services. The NASA Launch Site Integration Manager (LSIM) is the primary interface and ANALEX is the secondary interface. ANALEX shall represent the NASA Launch Site Integration Manager (LSIM) position at meetings, teleconferences, design reviews, technical interchange and working group meetings when the NASA Launch Site Integration Manager (LSIM) cannot attend.

ANALEX shall be the point of contact (POC) between spacecraft projects and other organizations including the Eastern Range (ER) and the Western Range (WR), Government/Commercial Payload Processing Facility (PPF)s, and Launch Service Provider (LSP)s.

2.1 Launch Site Documentation Services

ANALEX shall provide launch site documentation services.

ANALEX shall gather all documentation requirements from the payload customers by direct communication and through attendance to spacecraft and Launch Service Provider (LSP) meetings. ANALEX shall travel to the meetings if not held locally possibly involving foreign travel. These meetings include, but are not limited to the following: Project Kick-Off Meeting, Preliminary Design Review, Critical Design Review, Mission Integration Working Group meetings and teleconferences, Ground Operations Working Group meetings and teleconferences, Technical Interchange meetings, Pre-Ship review meetings. Launch Site Readiness Review, Flight Readiness Review, Launch Readiness Review. ANALEX shall use the information gathered and provide documentation services.

2.2 Launch Site Support Plan (LSSP)

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Launch Site Support Plan (LSSP). ANALEX shall publish and distribute preliminary and baseline versions of the Launch Site Support Plan (LSSP) with revisions as necessary. ANALEX shall catalog and incorporate changes to the Launch Site Support Plan (LSSP) and conduct detailed reviews with the payload customer in order to refine the document.

2.3 Program Introduction (PI) document for the Range

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Program Introduction (PI) document and submit to the Range.

2.4 Program Requirements Document (PRD) for the Range

ANALEX shall coordinate with payload customers in the identification, definition, and documentation of their requirements in the Program Requirements Document (PRD) for the Range.

2.5 Spacecraft Mission Operations Requirements (OR) document for the Range

ANALEX shall provide input to the Launch Service Provider (LSP) in the writing of the mission Operations Requirements (OR) document for submittal to the Range. ANALEX shall use the Launch Site Support Plan (LSSP) and Program Requirements Document (PRD) as well as further input from the NASA Launch Site Integration Manager (LSIM) and the payload customer to define and develop specific spacecraft inputs for the Launch Service Provider (LSP)-developed mission Operations Requirements (OR). ANALEX shall work closely with the Launch Service Provider (LSP) writer of the Operations Requirements (OR) to input these requirements. ANALEX shall review draft and published copies of the Operations Requirements (OR) for correctness. ANALEX shall modify Operations Requirements (OR) input as required.

ANALEX shall prepare the spacecraft Operations Requirements (OR) document for payloads processed in NASA and commercial Payload Processing Facilities (PPF). ANALEX shall use the Launch Site Support Plan (LSSP) and Program Requirements Document (PRD) as well as further input from the NASA Launch Site Integration Manager (LSIM) and the payload customer to develop a spacecraft-specific spacecraft Operations Requirements (OR) for spacecraft processing support in a Payload Processing Facility (PPF). ANALEX shall modify the spacecraft-specific spacecraft Operations Requirements (OR) as required.

2.6 Safety Advisory Function

ANALEX shall review customer requirements and advise the payload customer in safety planning including, but not limited to the following areas of facility requirements and modifications: mechanical, electrical, communications, contamination control, office space, telephones, base access and security.

ANALEX shall provide safety advice to the payload customer for the preparation the Missile Systems Pre-Launch Safety Package (MSPSP).

2.7 Review of Launch Service Provider (LSP)/Range-Provided Documentation

ANALEX shall review the Launch Service Provider (LSP) spacecraft Interface Control Document (ICD) and spacecraft questionnaire for completeness and accuracy of spacecraft requirements. ANALEX shall submit comments to the Launch Service Provider (LSP) after concurrence with the NASA Launch Site Integration Manager (LSIM).

ANALEX shall review and provide comments to the NASA Launch Site Integration Manager (LSIM) on Range-authored support documentation to ensure the Range properly addresses all customer requirements. This documentation shall include, but not be limited to the following:

- Statement of Capability (SC), which is the Range response to the Program Introduction (for Vandenberg Air Force Base (VAFB) missions only)
- Program Support Plan (PSP), which is the Range response to the Program Requirements Document
- Operations Directive (OD), which is the Range response to the Operations Requirements Document

- Network Implementation Plan (NIP), which is the Range launch day communications implementation plan
- Integrated Communications Requirements Document (ICRD), which is a communications annex to the Operations Requirements (OR) document

2.8 Launch Site Integration Operational Services

ANALEX shall perform the operational support tasks in coordination with the NASA Launch Site Integration Manager (LSIM).

2.9 Payload Transportation

ANALEX shall coordinate security escorts, and coordinate support from US Customs, Immigration and Agriculture Department for foreign payloads.

2.10 Payload Operations in the Payload Processing Facility (PPF)

ANALEX shall coordinate the review of payload customer test plans and technical operational procedures and track their approval status.

ANALEX shall perform the following tasks for payload operations in the NASA Payload Processing Facility (PPF)s:

- Distribute keys/combinations
- Coordinate facility and safety training
- Coordinate shipping and receiving services
- Coordinate access lists and guard orders
- Maintain a spacecraft activities log book
- Coordinate the procurement and use of consumables, supplies and materials
- Coordinate and schedule support for fueling operations
- Coordinate delivery radiation sources with the USAF
- Coordinate storage of pyros and radiation sources
- Coordinate photo support from the USAF
- Be cognizant of payload activities and reschedule support in response to anomalies and changes in plans

2.11 Payload Operations at the Launch Complex

ANALEX shall coordinate movement of payload ground support equipment (GSE).

ANALEX shall coordinate all launch complex access requirements including, but not limited to training, badging, security escort services, and tours.

ANALEX shall coordinate contractor support for off-shift operations, monitor payload activities, and reschedule support in response to anomalies and changes in plans.

2.12 Post Launch

ANALEX shall coordinate GSE movement, monitor customer clean-up/close-out activities, and coordinate shipping services.

3.0 Launch Operations Management Services

ANALEX shall provide launch operations management services in coordination with the NASA Launch Site Integration Manager (LSIM).

ANALEX shall coordinate between the Launch Service Provider (LSP), NASA Launch Director, NASA Launch Site Integration Manager (LSIM), and payload customer to produce the Launch Management Coordination Meeting (LMCM) presentation package. The Launch Management Coordination Meeting (LMCM) package shall include, but not be limited to launch day management and reporting structure; launch day "GO/NO GO" charts; list of mandatory assets for launch; launch day seating charts; launch day voice communication charts; and range conflict calendar.

ANALEX shall coordinate and schedule launch countdown rehearsals for the payload customer in the weeks prior to launch.

ANALEX shall, in coordination with the external public affairs organization, create and implement a plan to provide voice communications, video, timing, satellite up-links and down-links, and Launch Site Support Trailer (LSST) for coverage of a launch. ANALEX shall participate in planning meetings and teleconferences.

4.0 Launch Site Administrative and Customer Services

ANALEX shall provide secretariat function services for all launch site integration activities to include, but not be limited to the following: develop meeting minutes/actions and publish/distribute preliminary and final versions, prepare agendas and security access lists, coordinate meet-me numbers for teleconferences, arrange facility accommodations and presentation equipment, reproduce meeting materials, and record attendance

4.1 Launch Site Customer Services

ANALEX shall conduct the Launch Site Introduction/Familiarization Briefing for the payload customers. ANALEX shall prepare the briefing material to include but not be limited to familiarization/introduction of the launch site, list of points of contact, local community and center/base accommodations/capabilities, and any specific information related to facilities/equipment.

5.0 Mission Integration Coordination Services

ANALEX shall participate in each Expendable Launch Vehicle (ELV) mission through active participation of the Mission Integration Teams (MIT).

5.1 Integrated Mission Data, Documentation, and Schedules

ANALEX shall prepare a mission plan for each mission immediately preceding the Authority To Proceed (ATP) for the Launch Service Provider (LSP). The mission plan shall be accessible to payload customers through a controlled website.

Using inputs from the NASA Mission Integration Team (MIT), ANALEX shall prepare and maintain an integrated mission schedule that shall be compatible with Milestones Professional scheduling software. ANALEX shall evaluate mission integration schedules to identify potential schedule conflicts and inform NASA.

ANALEX shall maintain and NASA Payload Planner's Guide using information provided by the MIM.

5.2 Administrative Services

ANALEX shall develop documentation packages (e.g. Risk sheets, Mission Integration Working Group (MIWG) presentations) for mission management and NASA Mission Integration Team (MIT) activities to include, but not be limited to meetings, briefings, reviews and other activities that are at the Agency, Program, Project, and NASA Mission Integration Team (MIT) levels.

5.3 Secretariat Functions

ANALEX shall provide secretariat function services for all NASA Mission Integration Team (MIT) reviews to include, but not be limited to the following: develop meeting minutes/actions and publish/distribute, prepare agendas, coordinate meet-me numbers for teleconferences, arrange facility

6.0 Launch Engineering Team (LET) Services

ANALEX shall provide technical services to the Launch Engineering Team (LET) formed to support NASA and NASA-sponsored Expendable Launch Vehicle (ELV) launches to include, but not be limited to the following:

- Document, organize, and track internal and external action items that are significant to the LET in preparation for readiness reviews during the launch campaign such as Pre-Vehicle-On-Stand (Pre-VOS) Reviews, Systems Reviews, Flight Readiness Reviews (FRR), Launch Readiness Reviews (LRR), and related technical readiness reviews.
- Coordinate Technical Interchange Meetings (TIM) to include participation from offsite engineering organizations. Document, organize, and track internal and external action items that are relevant to the LET.

7.0 Communications and Telemetry

ANALEX shall provide engineering, operations, and maintenance of NASA communications and telemetry systems in all operational areas for NASA supported Expendable Launch Vehicle (ELV) missions including commercial and other payload customers of the NASA Program.

ANALEX shall provide technical interchange with NASA to provide status and immediately communicate any significant issues.

ANALEX shall be responsible for the following communications and telemetry support activities while processing at NASA and/or Commercial Payload Processing Facility (PPF)s:

- Operation & Maintenance of Communications and Telemetry Systems
- Disposition Requirements
- Engineering and Planning
- Setup and Activation
- Configuration Control
- Maintenance
- Troubleshooting
- Breakdown and Stowage

ANALEX shall provide troubleshooting and platform services for Expendable Launch Vehicle (ELV) customers where required. ANALEX shall coordinate and schedule customer requirements. ANALEX shall create a customer interface for data services to adapt customer equipment to the facility transport where necessary.

ANALEX shall permit specific equipment to remain operational and un-attended during non-supported hours when requested by NASA. ANALEX shall report to NASA the risks associated with unattended operation of this equipment and shall take appropriate steps to mitigate these risks.

7.1 Communications Systems

Using Installation-Provided Property (IPP), ANALEX shall provide the following services to all NASA customers:

- Voice
- Video
- Data
- Timing

ANALEX shall request and schedule communications circuits and support from the responsible organizations to meet all requirements. ANALEX shall coordinate directly with these outside organizations to assist in the activation and troubleshooting of these assets. ANALEX shall field support equipment to outfit these communications circuits to satisfy customer requirements.

ANALEX shall provide real-time end-to-end testing and troubleshooting of all communication links. ANALEX shall provide communication services for the public affairs video and audio production and satellite uplink activities for all NASA sponsored missions. This shall include all required planning of external contractor video and audio productions and technical support to interface equipment with NASA communication and video circuits.

7.2 Telemetry Systems

ANALEX shall provide time-tagged reception, recording, processing, and display of all incoming telemetry data. Telemetry data shall consist of: FM/FM telemetry, PCM/FM telemetry and separate analog signals. This data shall arrive via hard-line, fixed RF antenna, NASA Integrated Services Network (NISN), Internet-protocol Operational Network (IONET), or modem. ANALEX shall provide playback telemetry data support including displays and strip-charts as required by NASA.

ANALEX shall plan, develop, maintain, and troubleshoot software on the telemetry processing systems as required.

ANALEX shall provide analog recording and reproduction of unprocessed telemetry data and timing. ANALEX shall make copies of these tapes as requested by NASA and deliver them to the appropriate destination. ANALEX shall create and maintain a set of paper strip-chart recordings for all major tests and launch attempts, and copies of these recording will be delivered to the appropriate destination.

7.3 Upcoming Launches Scheduling, Planning, and Status Reporting

ANALEX shall create, maintain, and implement an integrated schedule for all the services provided for each scheduled mission.

ANALEX shall provide implementation plans for meeting mission communications and telemetry requirements including design drawings, procurement documentation, resource allocation, agreements with external service providers, and detailed scheduling.

ANALEX shall participate in technical interchange meetings to provide status to NASA and to receive customer requirements. ANALEX shall also conduct facility and console familiarization presentations to NASA customers.

ANALEX shall participate in launch readiness reviews and briefings and provide presentations during these reviews on facility and equipment readiness status. ANALEX shall provide readiness reports to responsible critical activity review boards and status including testing results, training, certification, hardware and software status, and procedures. Prior to each Flight Readiness Review (FRR) scheduled 5 days before launch, ANALEX shall provide to NASA a detailed status of all equipment and resources required for the launch. This launch status briefing shall include but not be limited to:

- Configuration of all support equipment
- Version identification of all software
- Identification of all technical leads
- Any issues/concerns which may impact launch support
- Brief summary of any equipment, resources, or services which shall be used for the "first time" to support a launch
- Brief review of any problems which impacted the last launch and the actions taken as a result of these problems
- A formal declaration of the capability to support from ANALEX or sub-contractor

7.4 Technical Points of Contact (POC)

For each mission, ANALEX shall have a single point of contact in the following areas:

- Telemetry operations,
- Real-Time data processing,
- Communications,
- RF Systems operations,
- Mission Operations Director,
- Data Impound Coordinator

These POCs shall be responsible for the following:

- Providing NASA status on contractor support for the mission,
- Coordinating operation of the service during major tests and launch attempts for the mission,
- Provide the post launch briefing for services provided for the launch,
- Provide the problem report and resolution for issues and concerns that affected mission support.

7.5 Facilities, Facility Systems, and Support Equipment

ANALEX shall operate and provide routine maintenance of all Installation-Provided Property (IPP). ANALEX shall operate lifting equipment such as cranes and hoists and perform proof-load testing. When required, ANALEX shall proof-load payload customer equipment. ANALEX shall document results and provide NASA access to data related to maintenance records, troubleshooting efforts, problem causes, and corrective actions taken, proof-test certificates, operational and test procedures, and test data records in accordance with DRD-1, Access to Contract Data, Maintenance Records.

ANALEX shall provide electrician services to include, but not be limited to troubleshooting, reconfiguration, modification, and general maintenance of facility electrical systems.

7.6 Maintenance Management

ANALEX shall identify and document immediately upon discovery all real time problems related to mission-critical and safety-critical facilities, systems, and equipment. ANALEX shall coordinate resolution with all affected parties, including other contractors, to ensure effective responses and to provide mitigation.

ANALEX may be required to provide maintenance and repair in cases where the USAF Base Civil Engineering (BCE) services where the USAF support cannot be obtained in a prompt manner.

8.0 Base Operations Services

8.1 Administrative Support

ANALEX shall provide reproduction services and operation and maintenance of reproduction equipment.

ANALEX shall provide United States Postal Service and Vandenberg Air Force Base (VAFB) internal mail pickup and delivery.

ANALEX shall obtain photo and video services from the USAF 30th Visual Flight and provide coordination to satisfy NASA personnel, customer, and contractor photo and video requirements.

8.2 Graphics Services

ANALEX shall provide computer and manual graphics (drafting). This shall include, but not be limited to facility and equipment illustrations, organization charts, certificates, photograph, guest badges, and guest bus placards.

8.3 Transportation Services

ANALEX shall manage transportation services to meet all operations requirements to include, but not limited to spacecraft servicing equipment on site.

8.4 Shipping and Receiving

ANALEX shall provide services to include shipping, receiving, packing and crating, pick up and delivery of supplies, materials, equipment, and flight hardware. ANALEX shall receive all mail, packages, and truck shipments, check for damage, and notify end user of its arrival. ANALEX shall provide shipment services including overnight and point-to-point package delivery.

8.5 Laboratory Services

ANALEX shall operate and maintain gas-sampling equipment and obtain gas samples from tube bank trailers and K-bottles and coordinate chemical analysis from USAF Chemical Laboratory.

8.6 Non-Destructive Evaluation (NDE) Services

ANALEX shall provide test and inspection services including in situ NDE. ANALEX shall provide a written report detailing inspection results.

ANALEX shall perform non-destructive evaluation of handling equipment after structural modification and proof-load testing. The dye penetrant inspections shall be in accordance with American Society for Testing and Materials Standard Practice for Liquid Penetrant Examination (ASTM E 1417-99). Personnel performing the evaluation shall be trained in accordance with American Society for Nondestructive Testing (ASNT) documents ASNT CP-189-1991 "Standard for Qualification and Certification of Nondestructive Testing Personnel" and SNT-TC-1A "Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing."

8.7 Security Services

ANALEX shall manage all necessary services and equipment needed for security, access permits/badges, and locksmith services.

8.8 Permits and Badges

ANALEX shall provide area access permits/badges for temporarily assigned payload customers and other visiting personnel for access to payload or flight hardware processing areas.

ANALEX shall maintain records of badges issued and account for the non-issued badge stock. ANALEX shall assure that any person being issued an access badge has received the appropriate Safety training required for the corresponding location to be visited.

ANALEX shall provide controlled area permits/badges/entry authorization lists, when required by customer projects within NASA facilities assigned to ANALEX or sub-contractor. ANALEX shall verify that personnel obtaining permits, badges, or inclusion on an entry authorization list meet the requirements for unescorted access within the controlled area.

ANALEX shall provide badge requests for contractor personnel for access to USAF restricted areas.

8.9 Lock and Key Control

ANALEX shall provide lock and key control including periodic inventory of keys in the NASA/Vandenberg Air Force Base (VAFB) master key system, posting classified document containers, changing lock combinations, and maintaining key control records, for facilities where ANALEX has operations and maintenance management responsibility.

8.10 Security Inspections

ANALEX shall provide end-of-workday securing inspections for all NASA-assigned facilities, and log all security inspection efforts.

8.11 Guest Services

ANALEX shall receive/screen requests for visits and process/maintain records of visit requests and authorization letters. ANALEX shall coordinate with entry control personnel in accordance with USAF regulations to assure proper credentials are ready when the visitor arrives. ANALEX shall be prepared to resolve and expedite entry control problems with security officials.

ANALEX shall operate and maintain a system to provide foreign national escort services in support of payload operating schedules. ANALEX shall be responsible for providing continuous escorting and transportation services for foreign national visitors while on USAF/NASA property.

ANALEX shall develop and maintain visitor control lists as required for access to specific areas controlled by USAF and other contractors. ANALEX shall input data into the Visiting Personnel Security Database to include visiting personnel and their facility entry authorization at any given time.

9.0 Mission-Direct Support at Vandenberg Air Force Base (VAFB)

9.1 Payload Support

ANALEX shall provide transportation services for spacecraft and flight hardware to the Payload Processing Facility (PPF)s at arrival.

ANALEX shall provide transportation and setup services for support equipment including the Launch Site Support Trailer. ANALEX shall coordinate transportation and setup services with Communications and Telemetry personnel.

ANALEX shall operate, maintain, and setup the Spacecraft Close-out Shelter (SCS).

9.2 Clean-Room Services and Cleanliness Requirements

ANALEX shall prepare a Facility Contamination Control Plan. ANALEX shall ensure that all Clean Rooms and clean work area facilities and associated support equipment meet payload customer cleanliness requirements. ANALEX shall manage all clean room operations to assure customers follow all established contamination control procedures.

ANALEX shall provide assistance to customers in cleaning equipment prior to moving it into the clean room.

ANALEX shall operate and maintain clean room particle counting equipment.

ANALEX shall implement customer-produced contamination control plans. In the event the customer does not have a written contamination control plan, ANALEX shall coordinate/implement contamination control requirements with the customer.

9.3 Propellant Services

ANALEX shall coordinate requirements for propellant handlers ensembles with the USAF and the USAF protective equipment maintenance and operations contractor. ANALEX shall manage the scheduling of self-contained apparatus protective ensemble (SCAPE) and other propellant handlers protective equipment training for customers.

ANALEX shall coordinate the pre-operations and post-operations servicing of spacecraft fueling equipment.

9.4 Environmental Compliance

ANALEX shall ensure that NASA operations are compliant with all applicable federal, state, county, NASA, USAF environmental rules, regulations, and management plans. ANALEX shall maintain an environmental management program that closely interfaces with NASA and the USAF environmental management efforts. ANALEX shall act as the technical point-of-contact

(POC) and maintain a cooperative working relationship with USAF who has overall environmental compliance responsibility over all.

ANALEX shall represent NASA position in environmental meetings/working groups and provide to NASA evaluations/recommendations about the USAF position.

ANALEX shall provide environmental services to NASA for environmental programs. Services include technical regulatory consultation for interface with regulatory agencies; inspection of regulated facilities and systems; preparation of permits, reports, and other regulatory documents; and development and review of environmental documentation.

9.5 ANALEX shall provide environmental services to NASA operations including:

- Written evaluation and assessment of projects for requirements of the National Environmental Policy Act (NEPA).
- Preparation of NEPA documentation, e.g., Environmental Assessments, Environmental Impact Statements.
- Written evaluation of processes to determine permitting requirements and preparation of permit applications when identified.
- Ensure environmental permits are current and operations are in compliance with permit requirements. Written recommendations for corrective action to correct non-compliances.
- Preparation and delivery of reports to meet regulatory deadlines, e.g., permit compliance reports, Emergency Planning and Community Right-to-Know Act (EPCRA) reports, Toxic Release Inventory (TRI) reports, etc.
- Inspection of regulated facilities and systems for compliance in all media areas. Written recommendations and track corrective action for identified non-compliances.

ANALEX shall be responsible for management of hazardous materials throughout their life cycle – procurement, usage, and disposal. They shall:

- Obtain approval from USAF for use of hazardous materials.
- Maintain records of storage and usage for emergency management purposes and EPCRA and TRI reporting.
- Maintain material safety data sheets (MSDS) for hazardous materials used and/or ensure that MSDS are given to central location.
- Ensure safe storage and use of hazardous materials including development of operational procedures for storage, use, and disposal.
- Control, package, and process hazardous and controlled wastes generated during NASA operations in accordance with Federal, state and local procedures and regulations.
- Provide training to NASA personnel, contractors, and customers concerning the handling and use of hazardous materials and wastes to meet Federal, state, and local training requirements. Maintain the training records in a manner compliant with Federal, state, and local requirements.

10.0 Guard Services at Vandenberg Air Force Base (VAFB)

ANALEX shall provide for continuous (24 hours) guard services for NASA-sponsored payloads while processing in a NASA Payload Processing Facility (PPF) per each access entry at all times. ANALEX shall use authorized access lists and post orders detailing a minimum of tasks to be done to meet security requirements and exercise an emergency call tree.

11.0 Access Control Monitors (ACM) at Vandenberg Air Force Base (VAFB)

ANALEX shall provide trained personnel to perform as Access Control Monitors (ACM) continuously (24 hours) as rquired. Access Control Monitors (ACM) shall be responsible for monitoring personnel

limits in the facility, enforcing safety constraints, logging facility anomalies, contacting appropriate people in response to an anomalous condition, and operating the video and communications systems within the Hazardous Processing Facility. The Access Control Monitors (ACM) shall not perform as a security guard. In the event of an anomalous occurrence, the established call tree shall be exercised.

12.0 Satellite Uplink Services for NASA Public Affairs Support

For Vandenberg Air Force Base (VAFB) missions, ANALEX shall provide mobile satellite uplink services for a NASA sponsored mission to support mission-direct activities including an end-to-end communications test prior to launch day and/or a launch attempt.

13.0 Vehicle Engineering And Analysis

ANALEX shall perform engineering and analyses for the NASA Program. ANALEX shall review and evaluate Launch Service Provider (Launch Service Provider (LSP)) tasks and products delivered as part of each expendable launch vehicle launch service so that the NASA Vehicle Engineering Division can provide approval of mission unique items and a knowledgeable “go/no-go” for NASA missions.

As required, ANALEX shall prepare and deliver technical briefings to spacecraft and launch vehicle external review teams.

ANALEX shall have the ability to investigate and evaluate the design, modification, development, and implementation of all launch vehicle systems, ground support systems and equipment at all Expendable Launch Vehicle (ELV) and payload processing facilities and launch complexes used to provide Expendable Launch Vehicle (ELV) launch services to NASA. ANALEX shall review, evaluate and provide an assessment of launch vehicle systems where NASA identifies a requirement for technical insight into the development, design, manufacturing, testing, integration, and launch of the affected systems and launch vehicle.

ANALEX shall participate in Launch Service Provider (LSP) run reviews and payload customer reviews, which are chaired by NASA personnel, in order to provide technical evaluations and recommendations of the designs, analyses, manufacturing methods, tests, and operations presented at those technical meetings. The meetings include technical interchange meetings (TIM), mission integration working groups (Mission Integration Working Group (MIWG)), preliminary design reviews (PDR), critical design reviews (CDR), design certification reviews (DCR), Quarterly Program Reviews (QPR), Payload Planning Meetings, Payload Ground Operations Working Group (GOWG), Safety Review Meetings, Flight Readiness and Launch Readiness Reviews.

ANALEX shall review, evaluate, and provide technical assessment of all required Launch Service Provider (LSP) documents delivered as part of the integration of each Expendable Launch Vehicle (ELV) mission so NASA can approve items specified in the launch service contracts (e.g., Contract Data Requirements List (CDRL), Mission Integration Working Group (MIWG) minutes and action items). ANALEX shall be well versed in analyses methodologies used by all NASA Launch Service Provider (LSP)s. For assessments of Launch Service Provider (LSP) Contract Data Requirements List (CDRL), ANALEX shall provide a written report to the NASA Mission Integration Team to include a summary of the Contract Data Requirements List (CDRL) reviewed, rationale for agreement or disagreement, ground rules used for any contractor analysis performed, results and sound explanation which corroborate contractor analytic results, final conclusions and recommendations, and appropriate identification of risk and risk rating. At a minimum, ANALEX shall identify all significant issues that could potentially impact mission success, schedule milestones, or cost for NASA resolution with the Launch Service Provider (LSP).

Throughout the life cycle of each NASA mission, from identification of mission requirements until completion of post-launch data review, ANALEX shall gather data from Launch Service Provider (LSP)s

and spacecraft customers as well as perform their own independent research. ANALEX shall evaluate and assess mission specific launch vehicle systems, mechanical and electrical interfaces, mission-specific software, predicted spacecraft environments, and Launch Service Provider (LSP) actions for NASA missions. . Contractor technical assessments shall be provided to NASA for NASA resolution with the Launch Service Provider (LSP).

Throughout the build cycle for each NASA launch vehicle, from design requirements development until completion of post-launch data review, ANALEX shall participate in NASA and Launch Service Provider (LSP) technical activities and take all other steps necessary to maintain a knowledge base adequate to ensure prompt, accurate and complete evaluation of all flight and ground system technical issues or anomalies effecting NASA missions. The assessments shall include documentation of discrepancies, dispositions and corrective action plans. This requires knowledge for all Expendable Launch Vehicle (ELV) systems utilized by the NASA Launch Services Program Office, including knowledge of specific vehicles assigned to NASA and to non-NASA missions. .

ANALEX shall gather data, review telemetry, research requirements, review as-built documentation and as-run procedures, and perform any other investigative steps necessary to prepare and present evaluations to NASA-chaired Failure Review Board (FRB) meetings in the event of a failed mission. Evaluations of anomalies shall be presented to the Kennedy Space Center (KSC) Engineering Review Board. ANALEX shall evaluate the failed or anomalous systems in order to aid the determination of root cause so that NASA can direct or approve Launch Service Provider (LSP) corrective action plans and/or return-to-flight activities.

14.0 Mission Analysis

ANALEX shall provide rapid, accurate, and complete assessments of analytical items throughout the life cycle for each NASA mission and build cycle for each NASA vehicle. ANALEX shall perform reviews of Launch Service Provider (LSP) provided documents in order to ensure prompt technical assessments of all relevant issues that arise during the integration process. Evaluation of these issues may require ANALEX to perform an independent analysis in order to verify or better understand the Launch Service Provider (LSP) data. Documentation of evaluations and recommendations to NASA shall be such that NASA approval of analyses and/or direction to the Launch Service Provider (LSP) for corrective actions can be accomplished. The analytical areas that shall be covered include the following:

- Loads and Structural Dynamics
- Dynamic Environments
- Stress
- Flight Design
- Flight Software
- Controls and Stability
- Thermal/Thermodynamics
- Electromagnetic Compatibility
- CFD/Aerodynamics

ANALEX shall evaluate Launch Service Provider (LSP) analyses for compliance with applicable mission and vehicle requirements for each of the disciplines listed above so that the NASA Vehicle Engineering Division can provide prompt approval of mission unique items and a knowledgeable “go/no go” for NASA missions. ANALEX shall evaluate and provide technical assessments to NASA of the relevant Launch Service Provider (LSP) Contract Data Requirements List (CDRL), vehicle system design, testing (such as that required for flight software or environments), robustness in the areas of performance and reliability, and post flight data.

For all of the disciplines listed above, specific technical expertise required by ANALEX shall include the ability to:

- Develop and create complex vehicle models
- Simulate these models using relevant code
- Modify or update analytical code as required
- Understand the Launch Service Provider (LSP) tools and models such that input and output files can be reviewed efficiently and accurately.
- Review incoming reports and perform analytical checks as required

15.0 Vehicle Systems Engineering

ANALEX shall provide rapid, accurate, complete assessment of vehicle systems issues and provide notification to the NASA Vehicle Systems Lead and the NASA Chief Engineer in accordance with the Engineering Review Process. ANALEX is responsible for reviewing and evaluating Launch Service Provider (LSP) tasks and products so the NASA Vehicle Engineering Division can provide prompt approval of mission unique items and a knowledgeable "go/no-go" for NASA missions. ANALEX or sub-contractor's vehicle systems engineers shall evaluate and provide technical assessments of the Launch Service Provider (LSP) launch vehicle systems design, analyses, manufacturing, verification, validation, assembly, integration, testing, checkout, and launch preparations for compliance with applicable requirements and robustness in the areas of performance, safety, reliability, and quality.

ANALEX shall provide expertise in the following areas:

- Electrical/Avionics Engineering: electrical wiring avionics boxes, guidance and control systems, vehicle instrumentation, vehicle telemetry, vehicle Radio Frequency (RF) systems vehicle power systems, data acquisition/handling systems and Ground Launch Control Software, and electrical ground support equipment.

- Mechanical/Structural Engineering: structures, composite materials, payload adapters, mechanical separation systems, pneumatics systems, hydraulics systems, liquid and solid propulsion systems, ordnance systems, and contamination control methods.

16.0 Electrical/Avionics Engineering

ANALEX shall assess flight and ground Expendable Launch Vehicle (ELV) electrical and avionics systems for NASA's determination of their readiness for launch.

ANALEX shall assess mission unique requirements imposed on the design, modification, development, implementation, and flight performance of all electrical and avionics systems.

ANALEX shall participate in, and assess launch vehicle processing, payload integration and testing activities at both the launch site and at payload customer facilities (e.g., fit-checks) to verify overall Launch Service Provider (LSP) compliance with test procedures and acceptability of test results

17.0 Mechanical/Propulsion Engineering

ANALEX shall assess flight and ground Expendable Launch Vehicle (ELV) mechanical and structural systems for NASA's determination of their readiness for launch. ANALEX shall determine failure trends of components and investigate latent defects.

ANALEX shall review and assess mission unique requirements imposed on the design, modification, development, implementation, and flight performance of all mechanical and structural systems.

ANALEX shall participate in and assess launch vehicle processing, payload integration and testing activities at both the launch site and the payload customer facilities (e.g., fit-checks, environmental testing, payload shock testing) to verify overall Launch Service Provider (LSP) compliance with test procedures and acceptability of test results. In addition, ANALEX shall evaluate and make recommendations on payload mechanical compatibility drawings for human access verification.

ANALEX shall participate in and assess Launch Service Provider (LSP) plans to comply with mission cleanliness requirements in processing facilities, during transportation and payload/Expendable Launch Vehicle (ELV) integration, and under fairing environments. ANALEX shall provide expertise in materials utilization/compatibility with mission unique requirements according to contamination control plans.

18.0 Electronic Drafting

ANALEX shall provide electronic drafting capability to create, design and maintain 2-dimensional (2D) and 3-dimensional (3D) drawings.

ANALEX shall develop and maintain diagrams, schematics, modeling for accessibility and/or feasibility assessments for mission integration requirements and launch vehicle systems. ANALEX shall provide diagrams, schematics and modeling studies as part of the Engineering Review Process and the Mission Integration activities. Results to be supplied on hard copy and electronically to NASA.

EXHIBIT 2

Supporting Technical Data
on
Centre National d'Etudes Spatiales
CALIPSO Sensor Description

Mission Partners

Selected in December 1998 as the 3rd NASA Earth System Science Pathfinder (ESSP) mission, a partnership involving:

NASA Langley Research Center: mission lead, project management, systems engineering, payload mission operations, data validation, data processing and archival

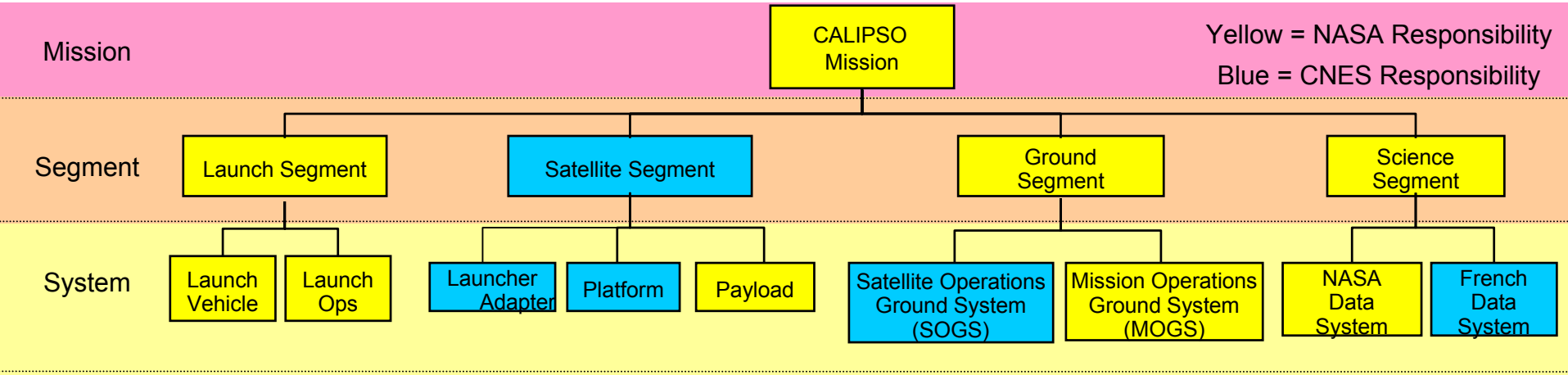
Centre National d'Etudes Spatiales: providing Alcatel PROTEUS spacecraft and Imaging Infrared Radiometer (IIR), payload-to-spacecraft integration, spacecraft mission operations

Hampton University: Level 2 algorithm implementation, educational and public outreach

Institut Pierre Simon Laplace: French science studies lead, IIR algorithm development, data validation and archival

Ball Aerospace and Technologies Corporation: lidar and wide-field camera (WFC) development, instrument-to-payload integration, launch vehicle support, and science data downlink

NASA/CNES Implementation



- Mission-level vs. Segment-level responsibilities
  - Segment to Segment interfaces are a mission level responsibility
  - Interfaces within a Segment are managed by the Segment lead

Mission Organization

ESSP GSFC Office

International Science Advisory Panel
M. P. McCormick

Code Y
D. Anderson

CALIPSO
PI: **D.M. Winker, LaRC**
Co-PI: M.P. McCormick, HU
Co-PI: J. Pelon, IPSL (France)

Mission Advisory Panel (MAP)
LaRC: Head, Proj. Implemen. Off.
CNES: Orbital Systems Dir.
CNES: Atmo., Meteo. & Oceans, Prog. Mgr.
Ball: Vice President
HU: Vice President
IPSL: Director
GSFC: ESSP, Prog. Mgr.

Education and Outreach
M.P. McCormick

Science Team
D.M. Winker

Mission Management
Project Manager: **J. F. Rogers, LaRC**
Deputy Project Manager: D. Dajon, LaRC
Deputy Project Manager: M. Blythe, LaRC
Deputy Project Manager: B. Belon, CNES
Deputy Project Manager, Resources: C. Bruno-Miller, LaRC

CloudSat
Tom Livermore

Mission Assurance
B. Heard, LaRC

Mission System Engineering Team
J. H. Stadler, LaRC

Mission Integration &Test
L. Brumfield, LaRC

Payload
K. Brown, LaRC
M. G. LaPole, Ball
- Lidar
- WFC
- IIR/CNES

Satellite
P. Castillan, CNES
J. Blouvac, CNES
- Platform
- Satellite AIT
- Satellite Ops

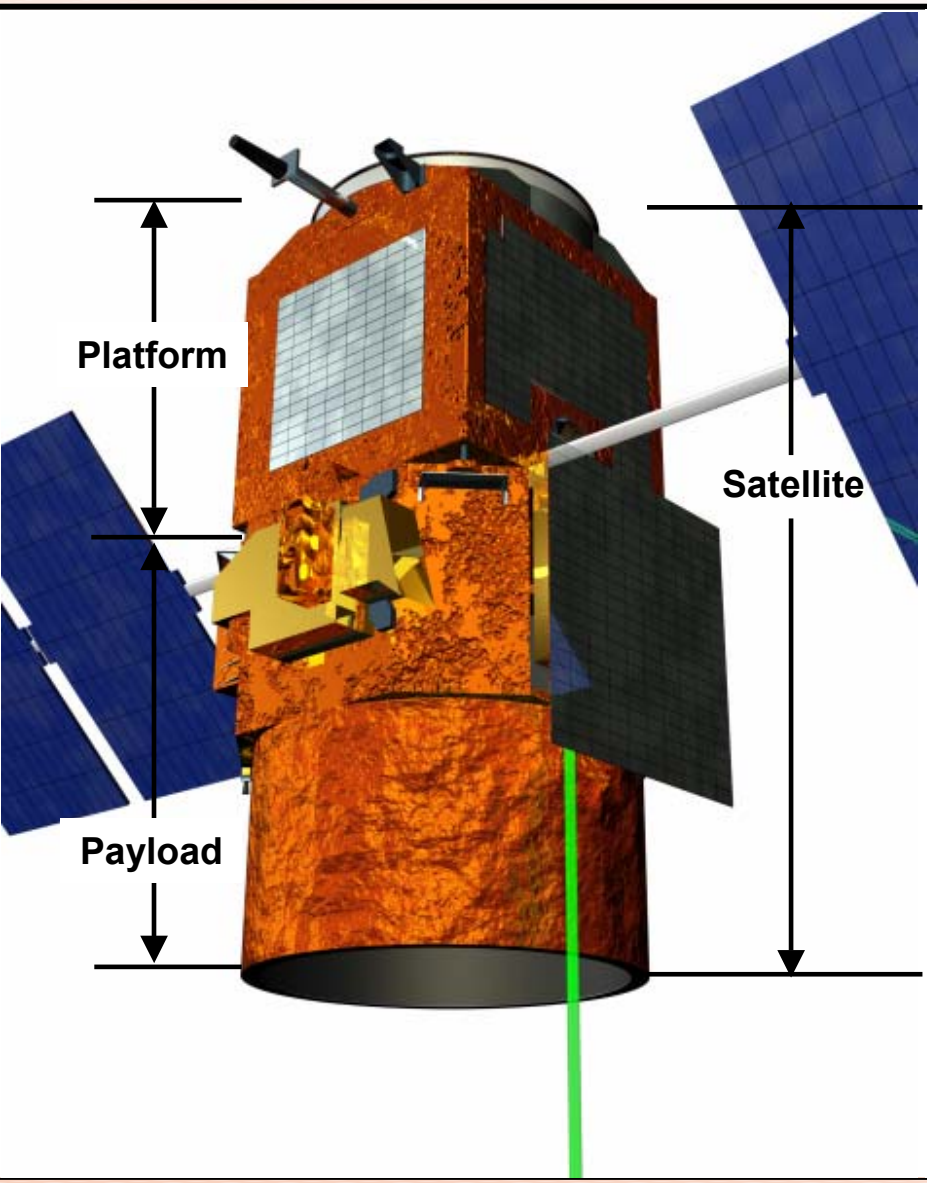
Mission Ops
M. B. Wusk
LaRC/GATS
- Mission Planning/ Analysis
- Payload Ops
- Mission Coordination

Ground System
V. Lucas, LaRC
- Ground Hardware
- Ground Software

Launch Segment
J. Wells, LaRC
R. Mueller, KSC
J. Dejoie, CNES

Science Segment
K. Cannon, LaRC
- Algorithm Development, LaRC
- Algorithm Implementation, HU/SAIC
- Science Data Mgmt, LaRC
- French Science Data Site CNES/IPSL

Satellite Segment Overview



Platform

- Contributed by CNES
- COTS PROTEUS platform
- Services:
  - Power Generation, Storage & Distribution
  - Attitude and Orbit Control
  - Command Control
  - S-Band Telemetry System
  - Thermal Control
  - Satellite Health Monitoring

Payload

- Built by Ball (LaRC Contract)
- Science Instruments
  - Lidar
  - WFC
  - IIR (contributed by CNES)
- Payload Controller
- Science Data Sub-System
  - Solid State Recorder
  - X-Band Transmitter
  - X-Band Antenna

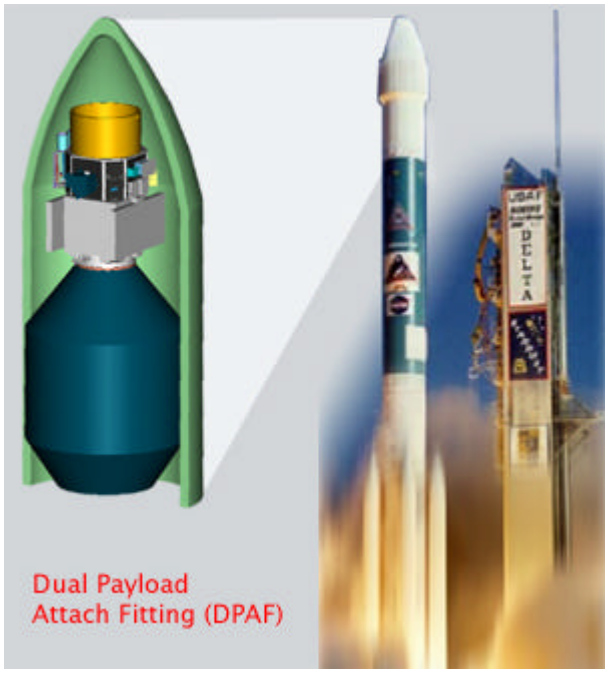
Overview

From: http://www-calipso.larc.nasa.gov/implementation/

The CALIPSO satellite will be developed to launch in 2005, followed by three years of on-orbit operation. The satellite consists of a science payload of three instruments integrated to an Alcatel PROTEUS spacecraft bus. CALIPSO will be monitored and commanded from CNES facilities in France.

The 36-month baseline CALIPSO mission is divided into the following five major phases:

1. **Ground Phase:**
   from satellite integration to launch vehicle ignition;
2. **Launch Phase:**
   up to satellite separation from the launch vehicle;
3. **Assessment Phase:**
   up to satellite in-flight acceptance;
4. **Observational Phase:**
   operational phase, includes science (data collection) and non-science (satellite orbit maintenance, non-nominal operations), until decision to cease science operations; and
5. **End-of-Life Phase:**
   after ceasing science operations (deorbit).



Launch Vehicle

The CALIPSO satellite will be launched on a Boeing Delta II 7420-10 launch vehicle in a dual configuration with the CloudSat satellite. The CALIPSO satellite shall occupy the upper berth position of the Dual Payload Attach Fitting (DPAF).

During Assessment Phase, CNES is in charge of conducting the flight operations with the support of NASA. During Observational Phase, NASA is in charge of conducting the flight operations with the support of CNES.

NASA is primarily responsible for overall coordination of the operations during the Observational Phase, the operation of the payload, of the Mission Operations Ground System (MOGS), and the U.S. science data system.

CNES is primarily responsible for overall coordination of the operations during the Assessment Phase, the operation of the satellite (this includes maneuver planning and execution), the Satellite Operations Ground System (SOGS), and the French science data system.

Instruments

CALIOP (Ball Aerospace)

Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) is a two-wavelength (532 nm and 1064 nm) polarization-sensitive lidar that provides high-resolution vertical profiles of aerosols and clouds. Examples of this measurement capability can be found at the LITE homepage. CALIOP has three receiver channels: one measuring the 1064-nm backscattered intensity, and two channels measuring orthogonally polarized components (parallel and perpendicular to the polarization plane of the transmitted beam) of the 532-nm backscattered signal. The receiver telescope is 1 meter in diameter. The full-angle field of view of the telescope is 130 microradians, resulting in a footprint at the Earth's surface (from a 705-km orbit) of about 90 meters. Dual 14-bit digitizers on each channel provide an effective 22-bit dynamic range necessary to measure backscatter signals from both clouds and the molecular atmosphere. An active boresight system is used to maintain co-alignment between the transmitter and the receiver.

Lidar Specifications

Lidar type	Nd:YAG, diode-pumped, Q-switched, frequency-doubled
Wavelength	532 nm and 1064 nm
Repetition rate	20 Hz
Telescope aperture	1.0 m
Horizontal/vertical resolution	333 m/ 30 m
Data rate	316 kbps

Imaging Infrared Radiometer (IIR) (CNES)

A three-channel Imaging Infrared Radiometer (IIR) is provided by CNES, with algorithm development performed by the Institute Pierre Simon Laplace (IPSL) in Paris. It is a nadir-viewing, non-scanning imager having a 64 km by 64 km swath with a pixel size of 1 km. The CALIOP beam is nominally aligned with the center of the IIR image. The IIR uses a single microbolometer detector array, with a rotating filter wheel providing measurements at three channels in the thermal infrared window region

at 8.7 µm, 10.5 µm and 12.0 µm. These wavelengths were selected to optimize joint CALIOP/IIR retrievals of cirrus cloud emissivity and particle size.

IIR Characteristics

Wavelength range	8.7, 10.5, and 12.0 micron
Spectral resolution	0.8 micron
Instrument field of view/ Swath	1 km/ 64km
Data rate	44 kbps

Wide Field Camera (WFC) (Ball Aerospace)

The Wide-Field Camera (WFC) is a modified version of the commercial off-the-shelf Ball Aerospace CT-633 star tracker camera. It is a fixed, nadir-viewing imager with a single spectral channel covering the 620-670 nm region, selected to match band 1 of the MODIS (MODerate resolution Imaging Spectroradiometer) instrument on Aqua. The WFC is operated in a push-broom mode, collecting images with 125-meter spatial resolution over a 61-km cross-track swath centered on the CALIOP footprint. WFC data is used in IIR retrievals and also provides meteorological context for CALIOP data. WFC data also allows highly accurate spatial registration, when required, between measurements from CALIPSO and other instruments in the Aqua constellation.

WFC Characteristics

Wavelength range	620 to 670 nm
Instrument field of view / Swath	125 m / 60 km
Data rate	26 kbps

CALIPSO is one of a series of NASA missions designed to examine critical issues in Earth system science. CALIPSO is a collaboration between NASA Langley Research Center and the French space agency Centre National d'Etudes Spatiales. Other members of the CALIPSO team are Ball Aerospace and Technologies Corporation, Hampton University, and the Institut Pierre Simon Laplace. The primary roles and contributions of the team members are:

Partners

NASA Langley Research Center (LaRC)

NASA LaRC leads the mission and provides overall program management, systems engineering, payload mission operations, science data validation, and data processing and archival.

Centre National d'Etudes Spatiales (CNES)

CNES provides the PROTEUS spacecraft and the Imaging Infrared Radiometer (IIR), and performs payload-to-spacecraft integration and spacecraft mission operations.

Ball Aerospace and Technologies Corporation (BATC)

BATC develops CALIOP and the wide-field camera and provides payload integration, launch vehicle support, and science data downlink.

Hampton University (HU)

HU, a historically black university located in Hampton, Virginia, leads the Level 2 CALIOP science algorithm implementation effort and manages the CALIPSO quid pro quo validation effort, education and public outreach program and International Science Advisory Panel.

Institut Pierre Simon Laplace (IPSL)

IPSL leads French science studies, IIR algorithm development, and contributes to science data validation.

The CALIPSO satellite is constituted of :

From http://smsc.cnes.fr/CALIPSO/GP_satellite.htm

- a **PROTEUS platform** (Plate-forme Reconfigurable pour l'Observation, pour les Télécommunications et les Usages Scientifiques). This platform is designed for 500 kg mass satellites at launch.

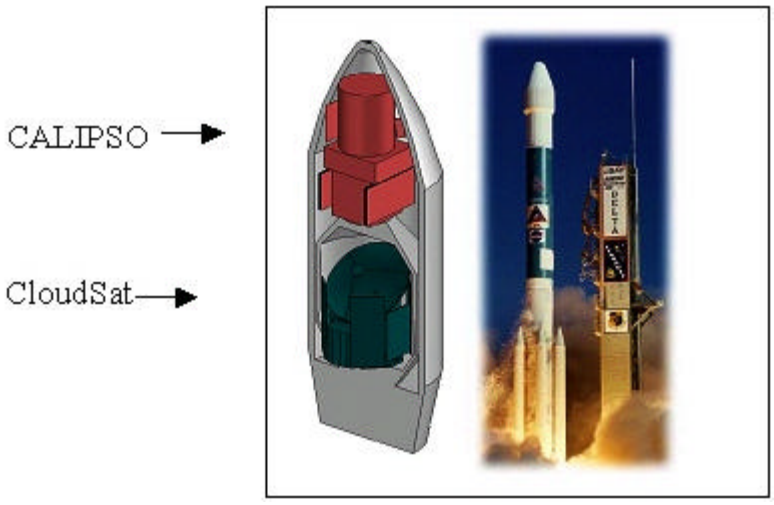
- a **payload** constituted of :

  - a two channels Lidar (main instrument, equiped of a 1 meter diameter telescope),
  - a Wide-Field Camera (WFC),
  - an Infrared Imager Radiometer (IIR)

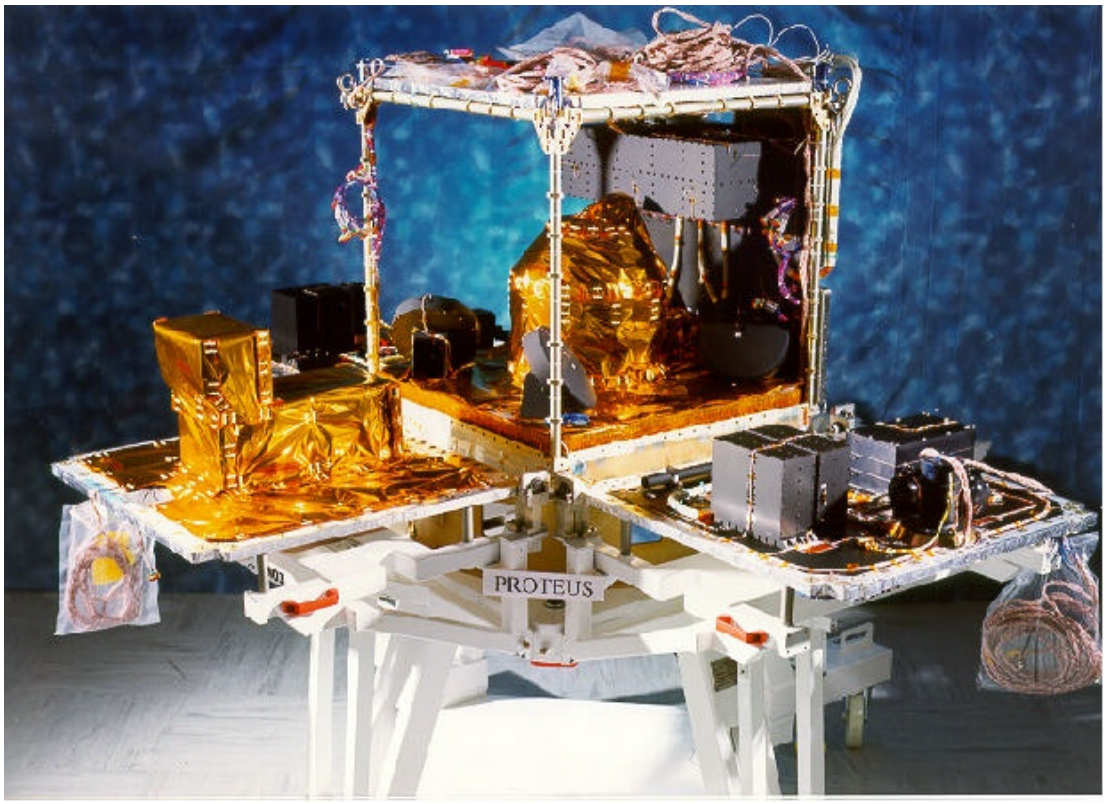
The satellite's main characteristics are :

Mass	635 kg
Power	560 W
S band telemetry	727 kbps for telemetry 4kbps for telecommands
X band telemetry	80 Mbit/s
Mission lifetime	3 years

The satellite will be put into orbit by a **Delta2** launcher supplied by **NASA**, and launched from **Vandenberg**, in **double launch** configuration with **CLOUDSAT**.



PROTEUS Multi-Mission Platform



Orbit	Every altitude between 500 and 1500 km. Orbital inclination above 15°.
Launcher	Compatible with every launcher which has a 1.9 m diameter fairing.
Mass	Maximum platform dry mass 270kg. Hydrazin capacity 28 kg. Payload Mass between 100 and 300 kg.
Reliability	0.875 for the 3 first years. 0.749 for the rest of the 5 years.
Life duration	between 3 and 5 years according to the chosen orbit.
Pointing	Standard 0.05° for each axis.
Power	Platform maximum consumption 300 W. Payload consumption class 200 W. Up to 300 W on some orbits.
Data storage	2 Gbits for the payload
Download	727 kbits/s

link	
Upload link	4 kbits/s
Downtime	0.88 %

The Proteus spacecraft bus is the basic module accommodating the housekeeping instruments required for the satellite to function, as well as the dedicated mission instruments. Proteus has been developed by Cnes to adapt to different minisatellites, thus cutting mission design costs.

The generic Proteus bus, developed in partnership by Cnes and Alcatel Space Industries, was used for the first time by the NASA launched Jason-1. The generic Proteus ground segment (control center and ground station) was also specially adapted for Jason-1.

Imaging Infrared Radiometer (IIR)

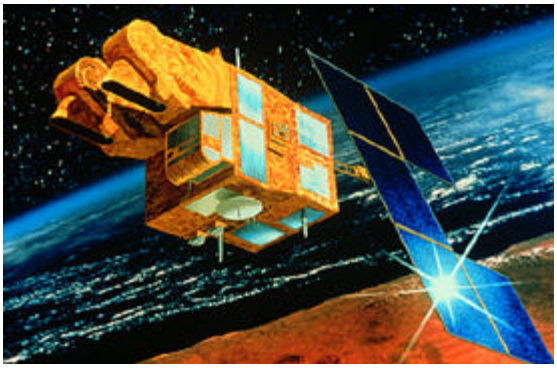
A three-channel Imaging Infrared Radiometer (IIR) is provided by CNES, with algorithm development performed by the Institute Pierre Simon Laplace (IPSL) in Paris. It is a nadir-viewing, non-scanning imager having a 64 km by 64 km swath with a pixel size of 1 km. The CALIOP beam is nominally aligned with the center of the IIR image. The IIR uses a single microbolometer detector array, with a rotating filter wheel providing measurements at three channels in the thermal infrared window region at 8.7 µm, 10.5 µm and 12.0 µm. These wavelengths were selected to optimize joint CALIOP/IIR retrievals of cirrus cloud emissivity and particle size.

IIR Characteristics

Wavelength range	8.7, 10.5, and 12.0 micron
Spectral resolution	0.8 micron
Instrument field of view/ Swath	1 km/ 64km
Data rate	44 kbps

CNES Missions

Spot



Satellites: ***Spot 2****, launched on 22 January 1990*
Spot 3*, launched on 26 September 1993 (stopped on 14 november 1997)*
Spot 4*, launched on 24 March 1998*
Spot 5*, launched on 4 May 2002*

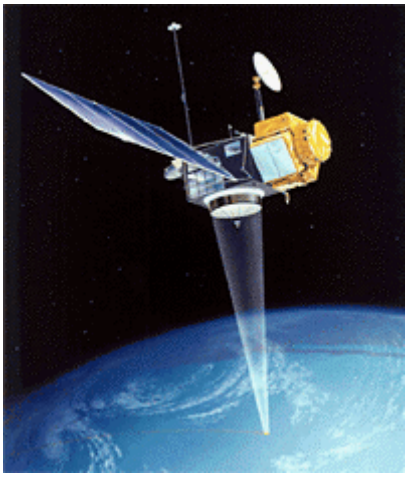
Mission: ***Earth observation***

Altitude: ***830 km***

The Spot family is designed and developed by the French space agency Cnes. The Spot system comprises several satellites, an orbit and mission control ground segment, a global network of receiving and processing stations, and an international product distribution and marketing network.

The spectral bands measured by the instruments have been carefully selected to match the Spot missions requirements, particularly for monitoring of crop and plant health, land management, topographic and relief mapping, ecosystem monitoring. Moreover, since Spot 2, the Doris instrument is onboard. Since Spot 4 Diode system able to localize the satellite in real-time.

The Topex/Poseidon mission



Satellite	***Topex/Poseidon***
Launched	***10 August 1992***
Mission	***Measure sea surface height***
Altitude	***1336 km***

The Topex/Poseidon satellite was launched on 10 August 1992 with the objective of "observing and understanding the ocean circulation". A joint project between Nasa, the US space agency, and Cnes, the French space agency, it carries two radar altimeters and precise orbit determination systems, including the Doris system.

Topex/Poseidon is laying the foundation for long-term ocean monitoring from space. Every ten days, it supplies the world's ocean topography, or sea surface height, with unprecedented accuracy. Topex/Poseidon is a space laboratory.

On September 15, 2002 Topex/Poseidon assumed a new orbit midway between its original ground tracks. The former Topex/Poseidon ground tracks are now overflown by Jason-1. This tandem mission demonstrates the scientific capabilities of a constellation of optimized altimetric satellites.

The Jason-1 mission

Jason-1 is the first satellite in a series designed to ensure continued observation of the oceans for several decades. It is the follow-on to Topex/Poseidon, whose main features it has inherited (orbit, instruments, measurement accuracy, etc.), and is being developed jointly by Cnes and Nasa. Satellite control and data processing operations will be performed by a new ground segment.

Jason's launch

Jason-1 was launched on December 7, 2001. The Jason-1 Launch vehicle is a Boeing Delta II 7920. The Delta vehicle is shared with another Nasa mission, Timed, with Jason-1 separated first. The launch site is Vandenberg Air Force Base.

Launcher

Boeing Delta II 7920

Vandenberg Air Force Base

CLUSTER

The European Space Agency (ESA) CLUSTER project, studies the interaction between the solar wind and the terrestrial magnetosphere. It observes phenomenons with caracteristic scale ranging from a few hundred to a few thousands km.

The four CLUSTER satellites were launched in July and August 2000 by two Soyuz launchers for a two years mission.
The mission was granted an extension of three extra years operation in early 2002.

At first the instruments on board the four CLUSTER satellites were provided by selected scientific teams and funded by their space agencies. In the CLUSTER case 3 out of the 11 instruments of each satellite were funded by the CNES. After the failure of the launch of the first four CLUSTER satellites in 1996, the new CLUSTER flight models, identical to the first ones, were developed by the scientific institutes under ESA contracts.

SOHO

The SOHO project, first cornerstone, with CLUSTER, of the ESA Horizon 2000 program, is part of the European contribution to international scientific programs STSP and ISTP studying the Sun-Earth relations.

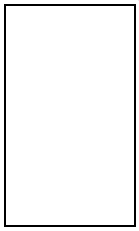
SOHO is an ESA satellite launched by NASA (which also receives the scientific data through its DSN network) and which instruments have been conceived and realized by European and american scientists.

The ESA Scientific Program Committee (SPC) approuved the 5 years SOHO mission extension after its nominal lifetime, which means from May 1998 to April 2003, then at the beginning of 2002, a new extension until March 2007. This eleven years lifetime (instead of the 2 initially decided) will enable to cover the totality of a solar cycle.

France participated greatly to the realization of 5 out of the 12 instruments intended to study several aspects of the Sun : the heliosismology, the electromagnetic radiation, the plasma and the solar wind.

SPI

SPI Integral the Gamma Ray Spectrometer on board Integral Spacecraft.



The Integral project (INTErnational Gamma-Ray Astrophysics Laboratory), on board which is SPI instrument,is dedicated to the study of gamma-rays. It was successfully launched on October 2002, the 17th.

SPI will observed with unrivalled spectral resolution and sensitivity the emissions of gamma-rays specific to nuclear reactions leading to the creation of elements within the Universe. Thus it will provide an understanding of the physical characteristics of specific celestial bodies such as supernovae, neutron stars, black holes and active galaxy nuclei.

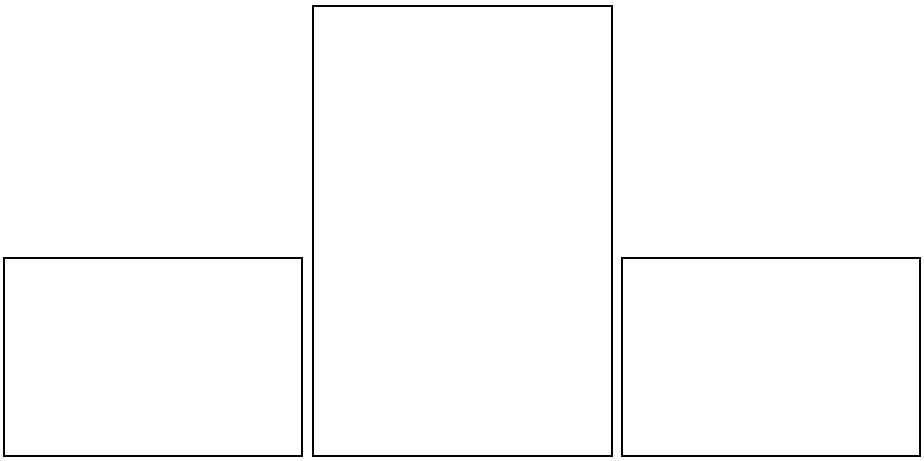
POLDER

POLarization and Directionality of the Earth's Reflectances

The French space agency, **CNES**, has developed the **POLDER** instrument, which flew on **ADEOS** (**AD**vanced **E**arth **O**bservation **S**atellite), developed by the Japanese space agency, **JAXA**. This was the first **French / Japanese** cooperative project in the area of Earth observation.

A second, identical instrument flew on **ADEOS-2**, successor to ADEOS, until October 2003.

POLDER is a wide field of **view imaging radiometer** that has provided the first global, systematic measurements of spectral, directional and polarized characteristics of the **solar radiation** reflected by the **Earth / atmosphere system**. Its original observation capabilities have opened up new perspectives for discriminating the radiation scattered in the atmosphere from the radiation actually reflected by the surface.



Pictures of POLDER 2 sensor integration phase on ADEOS-2.

OVH

OVH, acronym for OVerHauser magnetometer is a proton-precession magnetometer measuring the magnetic field amplitude.

It has been developped by the **LETI** (CEA) and provided by **CNES** and was embarked on board the **danish ØRSTED** satellite, along with other instruments.

ØRSTED has been successfully launched on the **23rd of february, 1999**, from Vandenberg, California.
The satellite is **still flying and acquiring** measurements of the Earth's magnetic field.

ODIN

ODIN is a dual purpose project dedicated to the study of both astronomical objects and the Earth's atmosphere.

The **ODIN** payload is a common resource and approximately half of the available spacecraft time shall be used for each scientific discipline.
ODIN is a Sweden project in cooperation with France, Canada and Finland.

The payload is composed of two main instruments :

- a **S**ub-**M**illimeter **R**eceiver (**SMR**). Radio signals are analysed by two Swedish auto-correlators and by an **A**cousto-**O**ptical **S**pectrometer (**AOS**) developped by France.

- **O**din **S**pectrometer and **I**nfra**R**ed **I**mager **S**ystem (**OSIRIS**)developped by Canada.

ODIN was **launched** on **February 2001 the 20th** with the Russian **START-1**, rocket, from Svobodny, Russia, for a **2 years** mission duration.

DORIS

DORIS (Dopler Orbitography and Radiolocation Integrated by Satellite) is Positionning System developped and monitored by CNES with participation of IGN and compounded of :

- a **network** of about **50** earth-based emitting **beacons**
- **DORIS receivers** on board satellites (**SPOT** series, **TOPEX/Poseidon**, **Jason**, **ENVISAT**...)
- a Data Processing Center

DORIS aims are :

- precise orbit determination, satellite navigation
- **geodesy** and study of the **solid earth** (geoid, positioning, tectonic monitoring, polar motion...)

SCARAB

Scarab is a four channels radiometer (visible, solar, total and infrared), made to measure the Earth's Radiation Budget. This scientific instrument was developed by LMD (Laboratoire de Meteorologie Dynamique) and by CNES (Centre National d'Etudes Spatiales).

The **Earth's Radiation Budget** is the net radiation flux, in other words the **difference between the solar radiation absorbed** (by the atmosphere or land), **and the infrared radiation** that escapes from the atmosphere into space. The budget for such radiation fluxes, which constitute the **only exchanges of energy between the Earth and space**, is an essential element in climatic balance. Though the Earth's Radiation Budget balances out in terms of annual global average, the same is not true on a regional scale, depending on the seasons. In order to **understand how the Earth's "climatic system" works**, it is vital to map Earth's Radiation Budget components and monitor its variation over time. Climatic change (linked to human activity, for example) can only occur in conjunction with a change in these budgets.

Initial estimations of the Earth's Radiation Budget date back to the **beginning of the century**, but it is only over the **past twenty years** or so, with the development of **satellites**, that **quantitative measurements** have become possible.

In addition, CNES has a multitude of mission currently in all phases of development.

EXHIBIT 3

List of Technical Documents

Exhibit 3 – List of Technical Data

This table summarizes the information covered in the International Agreement
between NASA and the Centre National d'Etudes Spatiale (CNES).
Listed in this table are the only portions ANALEX, and America Intellicom, Inc. (aka AISolutions) have potential to export.

Technical Data description
Mission Integration Working Group (MIWG), Ground Operations Working Group (GOWG) and Launch Operations Working Group (LOWG) will be conducted in accordance with the Medium Expendable Launch Vehicle Services (MELVS) . Discussion will involve the following
• Spacecraft to Launcher Interface Control Documents (ICD)
• Spacecraft/launch vehicle technical interface issues
• Technical splinters will be held as a part of the meetings on an “as required” basis
• Technical Interchange Meetings (TIMs) will be held as required on specific technical subjects/problems
• Telecons on specific topics also will be held as required
NASA/CNES Reviews & Launch Site Activities
• Flight Readiness Review
• Launch Readiness Review
• Launch Management Coordination Meeting
• Mission Dress Rehearsal
Payload processing, launch vehicle integration, and test
• Payload Requirements Document (PRD)
• Launch Site Support Plan (LSSP)
• Launch Site Test Plan
• Launch Site Procedures
• Combined System Test
Review/Comment on the following spacecraft deliverables
• P/L Launch Site Test Procedures, Final (S/C Stand Alone & Integrated S/C-L/V)
• Final Launch Window Constraints
• P/L Launch Checklist / Mission Constraints
• P/L Dress Rehearsal Requirements
Review/Comment on the following NASA deliverables
• Post-Launch State Vector
• Coupled Loads Analysis – Preliminary
• Coupled Loads Analysis – Final
• Preliminary Mission Analysis
• Final Mission Analysis
• RF link and compatibility
• Post Launch Quick Look Analysis
• FRR & LRR High Level Minutes

EXHIBIT 4

Technology Transfer Control Plan (TTCP)

Technology Transfer Control Plan
To accompany the
Technical Assistance Agreement
Between
Analex Corporation (U.S.) and Centre National d'Etudes Spatiale (CNES), (France)
for the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)

General: This Technology Transfer Control Plan (TTCP) is intended to supply guidance and direction to employees of Analex Corporation (Analex) and its subcontractors (if any) for protecting United States technology from inadvertent and illegal transfer to foreign nationals employed by any of the parties to the subject Technical Assistance Agreement (TAA) or any other agreement concerning CALIPSO. To be effective, a TTCP must identify what technology may be transferred or co-developed through discussion, display, or by physical means such as paper, e-mail, or Internet. It must identify to whom such transfers may be made and it must prescribe means to report the transfers and any violations of the terms of the TAA. Lastly, it must provide a means to both train employees and record that training.

Background: The National Aeronautics and Space Administration (NASA) has negotiated a formal Memorandum of Understanding or MOU with the Centre National d'Etudes Spatiale (CNES) that has the former agree to use its launch services contract to launch the cooperatively-built CALIPSO; to support its operations once on orbit, checked out, and functioning; and to share the Earth science data that CALIPSO will produce. The MOU calls for the signatories' centers and contractors to produce a detailed breakout of the tasks and responsibilities of the parties called the CALIPSO Project Plan that shall be empowered by the MOU and have the force of an international agreement.

CNES will provide the PROTEUS spacecraft bus, and the Imaging Infrared Radiometer (IIR) instrument, and performs payload-to-spacecraft integration of the those, plus the other two instruments (Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) and Wide-Field Camera (WFC) both provided by NASA, who purchased them from Ball Aerospace) and CNES will also conduct spacecraft mission operations, under NASA supervision.

NASA has contracted with Analex to provide the on-site payload-to-launch vehicle integration services under the ELVIS contract with NASA's Kennedy Space Center (which operates NASA's facilities at Vandenberg AFB, California.). Analex will perform a safety and mission assurance oversight role, launch site support engineering role, a launch operations management role, a mission integration coordination role, a communication and telemetry support role, to provide technical services to the NASA/Analex Launch Engineering Team (LET), provide on-site technical, security, and administrative support and assist in the technical preparation of the spacecraft at Vandenberg AFB, California, provide mission analysis of the following analytical areas: Loads and Structural Dynamics, Dynamic Environments, Stress, Flight Design, Flight Software, Controls and Stability, Thermal/Thermodynamics, Electromagnetic Compatibility & CFD/Aerodynamics, and perform engineering and analyses for the NASA Program, which necessitates this agreement.

Analex personnel will perform the work from Kennedy Space Center (KSC), and on site at Vandenberg AFB (VAFB), California to get the launch vehicle and CALIPSO payload integrated and ready for launch, and will assist with other tasks required of it by the CALIPSO Project Plan and the ELVIS contract Statement of Work or SOW.

What may be Transferred: The TAA authorizes Analex to carry out the tasks described in the CALIPSO Project Plan and the ELVIS SOW and to permit CNES's employees to have access to the technical documents described in the TAA. Thus, ANNEXES B and C and Exhibit 2 of the TAA, as allowed in the final State Department license; i.e., the TAA in the form and with the provisos returned to Analex by the Office of Defense Trade Controls, describe the techniques, know-how, and technical data that are permitted to be shared.

Training: All Analex employees working on CALIPSO are required to have completed Kennedy Space Center (KSC) web based training lessons: "Basic Export Control Program," "Foreign National Visit Processing," and Technical Information Exchange." These lessons are provided in CD-ROM format for those who do not have access to the internal KSC website or the NASA SOLAR website. All Analex employees working CALIPSO will read the CALIPSO Project Plan and the ELVIS SOW. These establish the procedures they are to follow and the limits to their cooperative work with CNES employees.

All training will be recorded by the Analex Program Manager (PM.)

Operations: From the first moment that Analex and CNES personnel start work until the final moment of such cooperation, Analex personnel will observe the limits to cooperation that the TAA permits. Logs or other records of topics discussed, documents accessed, issues resolved, and other cooperative work will be kept up to date and will be accessible to employees, managers, and NASA alike. Where the topics discussed and the work done are clearly within the framework of the TAA, these records need not be elaborate or detailed. Where there is any question of whether or not the material worked with falls within the bounds of the TAA, then detailed records of what was discussed, with whom, when, and where must be made. Such records must also be available as before, but it is the responsibility of the senior employee involved to make the Analex PM aware of the matter as soon as possible. If at any time any Analex employee is uneasy about what is being done or discussed, it is perfectly appropriate for the employee to terminate the activity at once and report it to the Analex PM or such person as the Analex PM has designated to receive these reports.

Physical security will be provided by NASA and Analex in accordance with the procedures specified by the Commander, 30th Space Wing, USAF. These procedures are stringent and call for 100% escort for all foreign nationals while on Vandenberg AFB. Compliance with these procedures supports this TTCP.

NASA has published its direction, procedures, and guidelines in NASA Program Directive (NPD) 1371.5, Coordination and Authorization of Access by Foreign Nationals and Foreign Representatives to NASA and NASA Program Guidance 1371.2, Coordination and Authorization of Access by Foreign Nationals and Foreign Representatives to NASA, use of

which is mandated by the ELVIS contract. NASA has also implemented an automated visit control system, the NASA Foreign National Management System (NFNMS). NASA's processes for handling foreign nationals call for checks of various U.S. Government agency lists to determine if individuals have been listed as barred from doing business with the Government or are otherwise to be carefully watched. NASA visit processes will be used to manage visits by CNES personnel to Vandenberg and to meetings, etc., held on the subject of CALIPSO. Compliance with these procedures supports this TTCP.

KSC Procedures for foreign national access to KSC and CCAFS are contained in Kennedy Handbook (KHB) 1610.1, KSC Security Handbook, Section 406. These call for a Technology Transfer Risk Assessment (TTRA) for visitors from certain countries and for any visitor who will be on station more than a total of 30 days in one year. This procedure is specifically extended for CNES personnel working at Vandenberg for more than 30 days in one year. Compliance with these procedures supports this TTCP.

Recording: All records, logs, notes, etc., that result from the operation of this TTCP will be maintained under the control of Analex' Empowered Official for five (5) full years after the expiration date of the Technical Assistance Agreement; i.e., five years from December 31, 2007.